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SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS

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Seeing in the Dark
Pulp Wood from Labrador
Succeeding in Railway Mechanical Engineering

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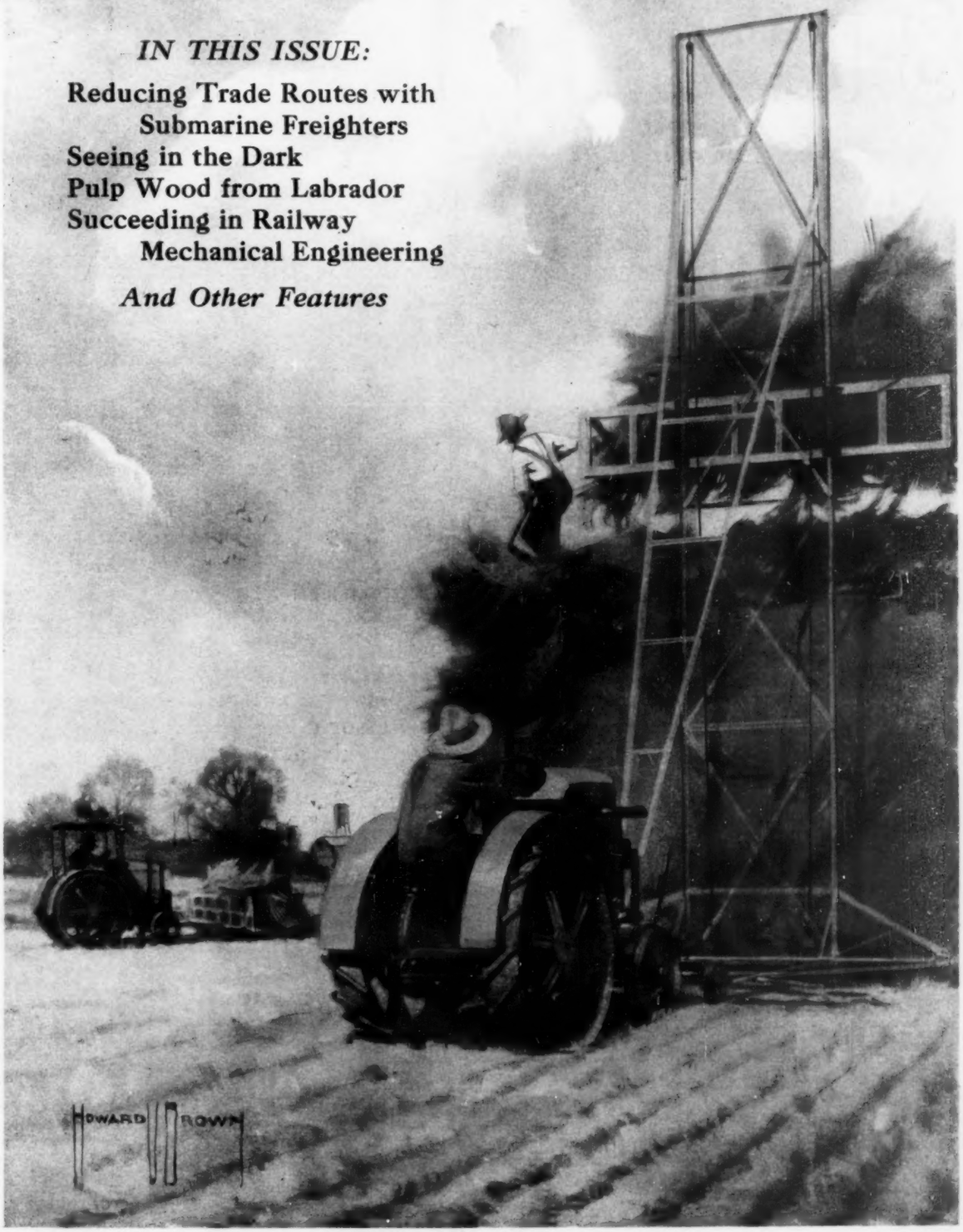

SPEEDING UP THE HAY HARVEST WITH THE GASOLINE TRACTOR, RAKE AND STACKER—[See page 157]

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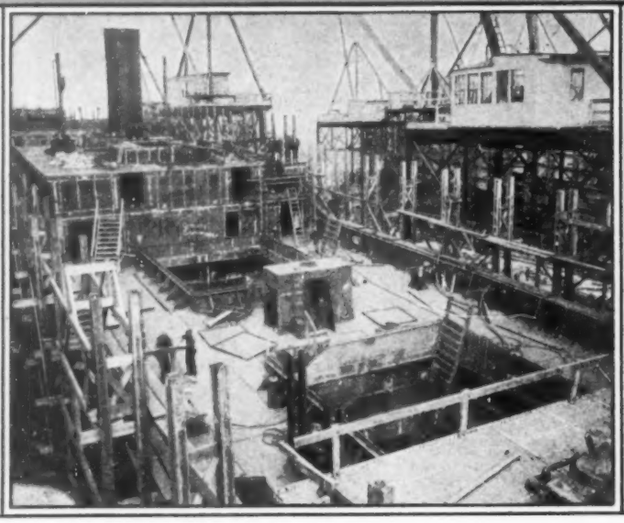
48-10



48-10

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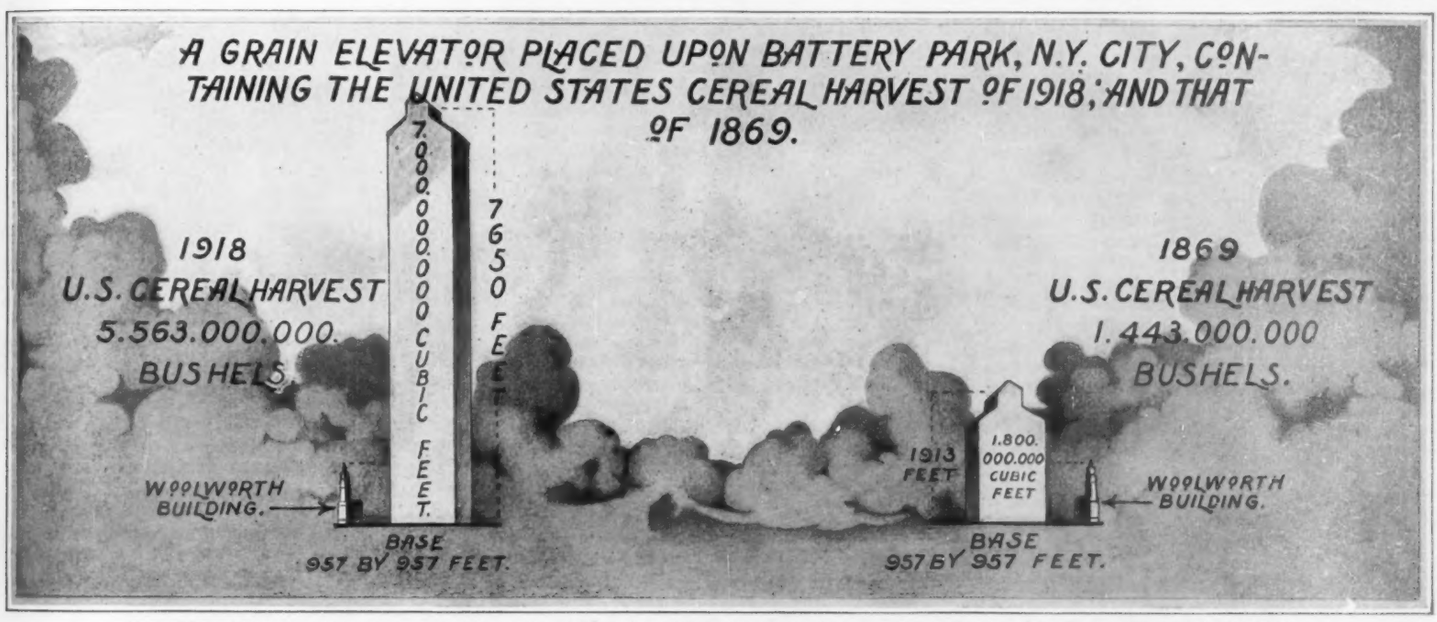
SEVENTY-SIXTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXIII. NUMBER 7] NEW YORK, AUGUST 14, 1920 [15 CENTS A COPY 20 CENTS IN CANADA



Some idea of the magnitude of our cereal harvest may be gathered from these graphic comparisons showing the crop for 1918 and that for 1869

If Our Cereal Harvest Should Descend on New York City

THERE are several cereals such as corn, wheat, oats, etc., and if the total amount of all cereals harvested in the United States should fall suddenly, like a heavy rain, upon New York City, such a cereal deluge would cover the metropolis to a depth approximating 9 6/10 inches. This does not seem very much cereal, but were it to be placed upon Madison Square it would then approximate a height of more than 4 miles! And, further, were all this cereal harvested in the United States to be placed in Madison Square upon a base having an area of 100 square feet, that is, a base 10 feet long by 10 feet wide, and then to be toppled over, it would fall, were it to be solid like stone, to a distance equal to about that of 5 times to San Francisco. Or, in other words, one year's cereal harvest in our country would, on a base containing an acre of land, rise to approximately the same height as would 214 Woolworth Buildings, placed one upon another.

Moreover, this annual cereal harvest would fill a street 100 feet wide running from the Battery to 44th Street to a height of about 3,315 feet; or a street 200 feet wide running from the Battery to near the city line to a height of about 432 feet; or a street 1,000 feet wide from the Battery to the City Hall to more than 1/3 of a mile. It would bury Union Square to a depth of 750 feet and there would be enough left of our country's harvest to bury City Hall Park under almost 4 miles of cereals. If our national cereal harvest should descend wholly upon Central Park it would bury that park to a depth of approximately 190 feet. And if this storm of cereals should descend upon New York City at the rate of one million bushels a day it would not cease falling upon that city for 19 years, that is, it would fall without stopping from 1919 till 1938. The accompanying graphic comparison, showing our cereal crop for 1918 and that for 1869, speaks for itself. It tells the story of our production.—By *Charles Nevers Holmes.*

Phosphoric Acid and Potash Now Produced

ALMOST unusual and novel application of electricity has recently been introduced commercially. It is the direct result of experience gained during the war and is a new use of electric furnaces regularly employed in metallurgical operations.

There are two types of electric furnaces used in the steel industry—one is the regular melting or refining furnace for making steel; the other is the shaft furnace in which most of the ferroalloys are made. A southern ferroalloy company, which, during the war made ferromanganese and several other alloys, found itself confronted with severe competition after the armistice and with the problem of finding a profitable use for its expensive equipment. The result of extensive investigations has been the following unique use of these furnaces.

The new departure involves the manufacture of phosphoric acid and of potash. The former has been made and is now being made by chemical processes on a large scale. Its electrical production is new, especially by the means referred to. Phosphate rock is put in the shaft electric furnace and smelted or disintegrated by the electric cement. Phosphoric oxide or P_2O_5 is formed, which passes off as a gas or in the gases. These are collected in chambers, and electric currents of high power are passed through the gases from which the phosphoric acid is precipitated as a powder. This is an application of the Cottrell electric precipitation method recently described in these columns. In this manner an unusually commercially-pure product is obtained free from many of the impurities introduced when sulfuric acid is the disintegrating medium acting on the rock instead of electricity. This product is further treated and concentrated.

In the case of potash the shale rocks of the Southern States, which are high in potassium compound, are introduced into the same kind of furnace and treated similarly. The product of this electrical disintegration is potassium oxide or potash, K_2O, which is also precipitated electrically from the gases which are evolved. Both of these products are valuable as fertilizers and the use of this process has a bright future.

The use of electricity in these two interesting cases instead of expensive chemicals is not only a feature of this new departure but there is the other novelty that electricity is used both as the destroying or breaking-down agent and as the medium by which the final products are recovered.

Hawaiian Motors Run on Molasses

FROM the lowly and sticky molasses is being produced "motor alcohol"—a substitute for gasoline. Discovered by J. P. Foster, chemist of one of the big sugar plantations on the Island of Maui, Hawaii, production within the next three months will be sufficient to furnish fuel for all cars on the islands should a gasoline shortage occur. According to the first reports of the new fuel brought to San Francisco "motor alcohol" gives more power, greater mileage, easier starting and more freedom from carbon than gasoline. It can be used without an adjustment of the carburetor.

The new fuel is performing in automobile, marine, stationary, truck and tractor engines. In a 36-hour test made with a 75-horse-power tractor the consumption of "motor alcohol" was four gallons an hour compared to four and a half gallons of gasoline in the same engine on the same work. Examination of the cylinders showed most of the old carbon deposit removed and the remainder so soft it could be removed with the fingers.

Sugar plantations have been letting their molasses run to waste or burning it for the potash recovery. Nitrogen and phosphoric acid are also valuable by-products of molasses. Now, however, production of the new fuel is found to be more profitable than obtaining other by-products.

At present there is enough molasses available to produce 9,000,000 gallons of "motor alcohol"—enough to supply all automobiles in Hawaii. Development of this industry will release shipping space formerly used for transporting gasoline from the United States.

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

A Prediction and Its Fulfilment

WE offer no apologies for republishing in this issue an article which was written ten years ago in a special aviation issue of the SCIENTIFIC AMERICAN that was brought out during the famous aviation meet at Belmont Park, in October, 1910. That meet was memorable because for the first time America was afforded an opportunity to see the very latest developments in aviation; for the best machines and the most noted fliers, both here and in Europe, were gathered at Belmont Park. Records were broken; and both as to speed of machines and skill of pilots, the gathering was literally, at that date, the last word in aviation.

The article was written without any wish to depreciate the skill either of the builders of the airplanes or of the pilots who flew them. Rather, it was stimulated by the conviction that the airplane development of that day was too much in the hands of the amateur, and, as invariably happens in such a case, successive machines too closely followed the lines of previous development. The writer felt satisfied that when the scientist and the practical engineer, as represented by Langley and Manly of the Potomac experiments, took up the work of development in good earnest, there would be a radical change from the curious and complicated constructions which prevailed at Belmont Park, with their multiplication of struts, ties, braces and other energy-consuming surfaces, and the airplane would be brought to its ultimate bird-like shape and fabricated in the wonderful constructional alloy steels which even in that day were available.

It is with a very natural satisfaction that we have witnessed the appearance, first in Germany, and later in this country, of the all-metal monoplane with its corrugated wing surfaces and its freedom from external struts and ties. The folding chassis as we then called it, retractable chassis as it is now known, has come into its own. Gyroscopic control of the ailerons as then predicted has been developed in practical form, and streamlining, as indicated in those early sketches, is now a *sine qua non* of all good airplane design.

By analogy, it is probable that the monoplane will be restricted to the smaller and medium sizes of machines. Plate girders can be used in railroad bridges only up to a certain length of span; above that length, the economics of construction call for the truss. So it will probably be found that although the monoplane is ideal for the smaller machines, the trussed biplane or triplane will be necessary when the wing span and the weights exceed certain figures.

If the development of the past decade has brought us to the stage of the perfectly streamlined metal monoplane, what will be the development of the next decade? We do not hesitate to predict that there will be more attention directed to the motive power and the propeller than to any other elements of the airplane. The internal combustion engine, even in such highly efficient and reliable types as the Rolls Royce, the Liberty and the Hispano-Suiza, is far from being an ideal airplane drive. It is noisy beyond all endurance, and in spite of the reliability shown in some of the recent flights, it does not possess the rugged durability and the absolute dependability which are demanded for a machine which becomes a comparatively inert mass the moment its engine ceases to function. For this reason, we believe that aeronautical engineers will turn their attention increasingly to that well-tried prime mover, the steam engine. With this will be coupled some type of feathering reversible propeller, which will be equally efficient at all altitudes, and will provide that powerful braking action, which is necessary to make the landing of an airplane as safe as its taking off.

Hudson River Bridge as a War Memorial

AS far back as the days of those master builders, the Romans, it was recognized that there was an inherent dignity and permanence in a bridge of proportions, which rendered it admirably adapted to serve as a memorial to great national achievements. An added fitness for memorial purposes is found in the fortuitous fact that the engineering requirements of bridge construction call for a distribution of materials which lends itself to great beauty of line and an impressive grouping of mass proportions. And not alone in the ancient world and in mediæval times, but in our modern age of steel the bridge has held its place as a worthy form of memorial; some of the finest crossings of the great rivers of Europe having been dignified in this way. It was altogether natural therefore that the Mayor's Committee on Permanent Memorial should have voted by a large majority in favor of making the great bridge which is to be built across the Hudson, a memorial to the soldiers of New York who took part in the World War.

Even if bridge memorials did not have the sanction of the centuries, the selection of the Hudson River bridge must necessarily appeal to our imagination and to our general sense of the fitness of things. As the recent conflict was the greatest war in all history, and our share in it was the supreme military effort of this country, it is fitting that this structure, which will be beyond all comparison the greatest single feat of engineering in this age of steel, should receive the added dignity of serving as a permanent national memorial. Architecturally it will meet every requirement of impressive magnitude, classic beauty, and assured permanence. Its great central span of 3,200 feet is just twice the length of the Brooklyn bridge, measured from tower to tower. Spanning as it does the noble river which, more than any other, is associated with the early history of the country, and looking down upon the river front from which our soldiers set out for the battlefields of Europe, it will be most aptly situated to fulfil the demands both of history and sentiment.

And it so happens that the masonry anchorages, which in a bridge of this size are necessarily of enormous proportions, lend themselves with peculiar facility to architectural and structural treatment of a memorial character. The anchorages which form the portals of the bridge will be masses of granite masonry, 220 feet in width, 340 feet in length, and over 200 feet in height. The upper deck of the bridge will contain in the center of its 200 feet of floor width a boulevard 80 feet wide, and entrance to the bridge will be made through three great arches in each anchorage —a central arch 100 feet wide, with side arches of half these dimensions, all three of these being executed in sculptural stone. After passing through these arches, there will be visible the four steel cables, each eight feet in diameter and covered with bronze plating, which will sweep in great curves to the top of four towers, each 650 feet in height. Although these towers will be built of structural steel, the steel work will not be visible, since they will be clothed from water level through the whole up-curving sweep of them with gray granite, each tower forming a tapering octagonal shaft, second only in height to the Woolworth tower, and many feet loftier than the Singer tower. The group of four towers will be pierced with three arches, granite or marble covered, of noble proportions, through which entrance will be had to the main span with its vast sweep across the river of 3,200 feet. The approaches from the Jersey side will be similar. It can readily be seen that the vast masonry surfaces will suffice for a display of sculptured emblematic and memorial work and bronze tablets on a scale commensurate with the dignity of the subject.

The designer of the Hudson River bridge, Gustav Lindenthal, wishes it to be clearly understood that the bridge as an engineering proposition will be built with private capital, and that the cost of the memorial features, only, will be borne by the city.

Is Naval Design in the Flux?

ARE naval design, construction, strategy and all the rest of it in a state of flux? When Beatty led the German fleet into contact with the British, Jellicoe, with twenty-five battleships, had the speed and power to close in and absolutely annihilate the Germans. Why did he not do so? Because of his very proper fear of the torpedo. He escaped torpedo damage by keeping the German destroyers at such a distance that their torpedoes were discharged haphazardly, lost their speed before they reached the British line, and were easily avoided by maneuvering.

Have you ever considered that the gas engine is liable to upset many of the theories and practices of naval construction and warfare? It is a thought well worth consideration, and we invite attention to it just now.

Is it not rather strange that the British should have scrapped half their battleship fleet and stopped all battleship construction? And that they should so complacently sit down and watch another navy spending seven hundred and fifty million dollars on eighteen battleships and battle-cruisers which, theoretically, when completed, will wrest from her that protective supremacy at sea which she has always believed, and still believes, to be necessary to the security of her far-flung empire? Why this complacency? If you asked Admiral Benson, he would probably answer: "They are hard up. It is necessity." But can we be so sure of this? Is it not possible that their vast war experience showed the British that the terrific punishing-power of the torpedo, due to new methods of bringing it within point-blank range of the enemy, demands a radical revision of some of our fundamental war concepts?

We believe that in future war the torpedo will at last come into its own, and it will be the internal combustion engine that will work the change. It gave us the motor car and the airplane, and now it is perhaps destined to dethrone the battleship and battle-cruiser as the supreme elements of naval strength. But how? Well, the British have several large and fast torpedo-plane carriers. Let us forecast a duel between a twelve-gun, 23-knot "Massachusetts," and a 32-knot torpedo-plane carrier, with twice that number of planes aboard. Steaming outside of 16-inch gun range, the carrier would send in her planes which, swooping down from great height at 150 miles an hour, would drop their torpedoes within close range and return for more. But the bulge will save the ship? No; for the torpedoes will be set to pass underneath the ship and they will be fired magnetically by the action of the steel mass of the ship itself. And you could not put side and bottom bulges, both, upon a ship—she would be all bulge and but little ship.

Again, the internal combustion engine has opened up another form of attack in the shape of the so-called one-man torpedo boat—a type which is coming along very fast. It begins to look as though the gas-driven, high speed, motor boat, carrying its torpedo discharge below water, would fulfil the functions in which the torpedo boat failed utterly and the destroyer partially. It has the torpedo efficiency of the destroyer without its size and visibility. To hit, the torpedo must be fired at close range—the Germans found that out at Jutland. The torpedo motor boat is so small a mark that it can dash in at thirty knots to within point-blank range without the anti-torpedo gunner being able to draw a bead upon it, so rapid is the change of range; and twenty sea-going motor boats can be sent in for the cost of one destroyer.

Seaworthiness? Well, they are growing in size, and the latest type would have no difficulty in keeping station as part of a fleet organization.

There are evidences, clear to the close student of naval development, that naval theory, construction, strategy and tactics are very much in the flux just now, or soon will be.

Electricity

Collapsible Tool Bag for Linemen.—There has recently been placed on the market a canvas tool bag for use in hoisting tools, paint and other implements or supplies by linemen. The bag is made with no metal parts that can come in contact with the current, as the sides are of canvas, the bottom is of wood, and the handle is of rope. The manufacturers have designed it to hold tools and materials which, if not properly taken care of, may be a menace to those below.

An Electric Pipe Thawer.—It is hardly seasonable to be speaking of pipe thawers; but winter must come sooner or later and pipe thawers are equipment which cannot be left to the last moment. There has been placed on the market a pipe thawer in a highly portable form. It consists essentially of a transformer, consuming ordinarily about 550 watts, a 10-foot lead for connection to the lighting circuit, and secondary leads equipped with cast-brass clamps for attaching to pipes from ½ to 1 inch diameter. Alternating current of 50 cycle to 60 cycle frequency and 100 to 125 volts is used. The spread of the secondary is 15 feet.

The Sheringham Daylight Lamp.—Owing to the variable intensity and color of daylight, according to season and climatic conditions, an artificial illuminant giving light equivalent to that from a diffused north sky would be of great value in many color-matching operations. In the Sheringham device a glow-lamp (or other illuminant) is placed under a large shade the inner surface of which is covered by a special design in colors. The lower half of the lamp is screened by a reflector which directs light upward on to the mosaic of colors, whence it is diffusely reflected. The colors can be so selected that the reflected light closely resembles diffused north skylight, light from a blue sky, or sunlight. A diagram is given showing the spectrum distribution of light from a blue sky, noon sunlight, a tungsten lamp, and the artificial daylight produced by the Sheringham lamp. The efficiency of the unit is stated to compare favorably with that obtainable from previous methods of producing artificial daylight.

Intensity of Wireless Signals.—A method of measuring and comparing the intensities of signals received by a radio station has been worked out in France with good results. This method, which can be employed only for undamped waves, essentially consists in comparing the intensities of reception of the signal and of the sound produced by a local source of oscillations, of the same frequency and form, constituted by an ordinary heterodyne. By modifying the intensity of the action of the auxiliary oscillation-generating device upon, say, the antenna, a rough equalization is first obtained, afterwards, by maneuvering convenient shunts to the telephone an absolute equality of intensities is obtained. The ratio of intensities is proportional to the shunt resistances. Moreover, by inserting a thermo-galvanometer in the antenna the absolute value of the intensity of the auxiliary signals can be obtained. The error in the practical use of this method is from 5 to 10 per cent.

France's Wireless Plans.—A dispatch from Paris states that the French Government has recently announced plans for an elaborate wireless system whose center will be in Paris and which will cover Europe, Asia, Africa and South America and connect with North America. If this system, part of which is already in existence, is integrally applied as now proposed, France's wireless communications throughout the world will be able to rival with Great Britain's cable communications. According to the details made public at a recent meeting at Rennes, wireless communication was established with Hungary May 20, 1920, and will soon be opened with Belgrade. For commercial communication with the United States there is a station at Doua, near Lyons, in addition to the Lafayette station near Bordeaux. Between France and its colonies there will be stations with a range of 7,500 miles at Saïgon and at Tahiti. Stations with a radius of at least 4,375 miles will be established at Djibouti, Tananarivo, Noumea, and French Guinea. In Africa the system will include stations at Saida and Bamako, which will take care of the traffic between Paris, Algeria and West Africa; another station in Senegal, near Dakar, and finally that of Brazzaville.

Science

Collection of Aeronautical Instruments.—The official collection of aeronautical instruments maintained by the Bureau of Standards in Washington is said to be one of the most comprehensive in the world. It includes instruments of French, German, British, Italian, Russian, Swiss, Danish, Dutch and Austrian manufacture as well as those made in America.

Biochemical Research at Cambridge.—The University of Cambridge has received from the estate of the late Sir William Dunn a large fund to be used in endowing biochemical research and instruction at the university. A minimum total expenditure of $825,000 is contemplated for the erection and equipment of buildings and the endowment of a professorship and a lectureship.

Marine Laboratory in Hawaii.—The University of Hawaii has received a fund from the C. M. Cooke estate which is to be used in establishing a marine biological laboratory in connection with the Honolulu Aquarium at Waikiki now under the supervision of the university. Facilities will be provided for work by visiting scientific men. Biologists who wish to use the laboratory should communicate with Prof. C. H. Edmondson, the director.

The Mango in Florida.—The U. S. Department of Agriculture has secured through its agricultural explorers and by exchange with the British East Indian departments of agriculture one of the largest collection of mango varieties in the world, and now has in fruit, at its plant introduction station at Miami, Fla., about 20 varieties, selected from a much larger number. It is said that these selected varieties strikingly belie the many unkind things that have been said about the mango and that are really applicable only to the inferior sorts. Some of them have hardly more fiber in them than a freestone peach, and can be cut open lengthwise and eaten as easily with a spoon as a cantaloupe. They have a delicious odor, suggestive of pineapples. The mango is destined to become one of the important products of southern Florida, south of the line of heavy freezes.

The Reappearance of Minerva.—The 1920 issue of the *Minerva Jahrbuch der gelehrten Welt* has recently appeared, this being the first issue since that for 1913-14. It was expected that this unique international directory of scientific establishments and their staffs might be made superfluous by the publication of the new French *Index Generalis*, but as the latter (judging at least from the initial volume) is only a directory of educational establishments, the two works do not cover identical ground. The latest *Minerva* is extremely incomplete for many countries, and for obvious reasons, but contains addresses and statistics not available from other publications pertaining to the scientific establishments of Germany, Austria and Hungary, besides much information relating to Switzerland, Denmark, Sweden, Norway, Holland, Bulgaria, Esthonia, Czecho-Slovakia and a few other parts of the world. *Minerva* is now published in Berlin and Leipzig, instead of Strassburg.

Rasmussen's Studies of Eskimos.—The remarkable studies carried out by the Danish explorer, Knud Rasmussen, among the Greenland Eskimos are described by Mr. W. E. Ekblaw in the *Geographical Review*. Rasmussen, who is part Eskimo himself, was born and partly educated in Greenland and trained in languages and ethnology at the University of Copenhagen. It is his ambition to make a thorough study of the whole Eskimo race, from eastern Greenland to Siberia, and he has already visited every Eskimo settlement in Greenland. It is said that he knows every Greenland Eskimo personally. Mr. Ekblaw believes it safe to say that no one else has ever come into such direct contact with a whole people as he has. Late in 1919 he returned from a visit to Ammassalik, on the east coast. He was surprised to find that the East Greenland Eskimos preserve many of the customs of the Central Eskimos, who still inhabit the ancestral home of the race about Hudson Bay. He found that they are more closely related to the Central Eskimos than are any of the other tribes of the entire Greenland coast, and that only recently have they been affected by contact with the Greenland west coast culture.

Industrial Efficiency

Tanned Sponges.—An interesting process has recently been developed for increasing the efficiency and extending the life of sponges used for technical purposes, automobile washing, office use, etc.—in fact for all purposes except use on the human anatomy. It consists in a modified tanning process, and it makes the sponge take the water much better and act more satisfactorily in giving it up to the work.

Our Business in India.—With the United States and Japan each maintaining advantageous business in India and British manufacturers endeavoring to regain their pre-war position in this market, competition is keen for the trade of that country, according to the *Trans-Pacific*. Textiles and machinery mainly from England, cotton hosiery, silk piece goods, and glassware chiefly from Japan, and electrical machinery and automobiles almost entirely from the United States, supply India's demands in these lines at present. The importation of paper from the United States during the last year greatly increased, and American manufacturers successfully furnished the Indian market with supplies of hardware, bolts and nuts, nails, rivets and machinery and mill furnishings generally.

New Uses for Stainless Steel.—Since the Armistice there has been an enormous sale of stainless steel for cutlery purposes. The demand is increasing, and the labor and machinery in the Sheffield cutlery trade are inadequate to deal with the influx of orders. Stainless steel is being employed very largely in the manufacture of pump rods, valve spindles, valves and other parts which are exposed to contact with water, steam and other corrosives. The scientific instrument trade is using it for drawing instruments and other precision tools and for surgical instruments. It is being manufactured into stair rods, saucepans, and pans of varying shapes, fenders for the hearth, and even into pokers and garden implements; and butchers' rails, spikes, skewers, saws, and other butcher-shop requirements are being made from it. Stainless steel is also being used for golf-club heads, spurs, etc.

Long-Distance Rafting.—Swedish lumbermen are on this coast investigating the possibility of rafting lumber from British Columbia to Europe. Lumber rafts of large size, called rafanutes, have been successfully towed from Sweden to Great Britain. The Ocean Rafanute Syndicate, of London, England, has sent William Olsson, of Stockholm, an experienced rafanute builder here, to investigate the possibility of adapting that method to British Columbia timber exports. The rafanutes are made of squared timbers. Mr. Olsson, though expressing nothing definite, believes that the tremendous timbers of the British Columbia forests will make possible the construction and successful operation of rafanutes far larger than the rafts now shipped out of the Baltic. Swedish structures carry four or five million feet each. It is proposed that the British Columbia rafts will contain fifteen to twenty million feet.

Wanted: New Uses for Rubber.—The Rubber Growers' Association of London is offering certain sums of money, as below, for ideas and suggestions for extending the present uses or for encouraging new uses of rubber. The awards consist of: First, £5,000; second, three prizes of £500 each; third, ten prizes of £100 each, and a sum not exceeding £1,500 to be divided among the remaining competitors whose suggestions are considered to be of value, according to the relative value of their suggestions, but so that no competitor will receive more than £100. The association points out that "suggestions must be practical and likely to increase the demand for the raw material. Ideas will be welcomed for the application in new directions of existing processes, methods, or manufactures, or for improvements or new processes which will facilitate or cheapen the production of rubber goods. Competent judges (technical and otherwise) will be appointed to investigate and adjudicate upon the suggestions received." The latest date for receiving suggestions is December 31st, 1920, and no envelopes containing the same will be opened before that time. Full particulars of the conditions governing this competition can be obtained from the Rubber Growers' Association, 38 Eastcheap, London, E. C., 3, England.

Reducing Trade Routes with Submarine Freighters

How a Special Type of Submarine Might Be Employed for Traversing the Arctic Ice Fields

By Robert G. Skerrett

THE Northeast and the Northwest Passages, with their strong appeal to the venturesome navigators of other days, are likely to be turned to thoroughly practical commercial account in the near future, thanks to potential developments in the realm of under-water travel.

In the course of the last five years the submarine evolved from a coastal or harbor defense craft into a vessel capable of taking to the high seas and holding her own in the open ocean for weeks' running. But probably no phase of this department of naval architecture has been more suggestive than that typified by the German subaqueous freighter "Deutschland" of something like 1,700 tons. Simply because she was the lone example of her class to reach our shores and to win any considerable notoriety, little heed has been given to the significance of her performances.

Simon Lake, however, is thoroughly convinced that the cargo-carrying submarine has a conspicuous and a valuable part to play in peace-time trade; and he has brought his wide experience in subsurface navigation to bear in designing a submergible freighter especially suited to following routes normally considered closed to the average merchant steamer. In these days when labor is high; when the world cries aloud for an abundance of raw materials; and when time, indeed, means money, any agency which will shorten the journey of essential commodities, will abridge the transit period, and, in effect, bring widely separated points on the globe much nearer together, will prove a veritable boon.

Despite the fact that Sir Robert McClure, during his expedition of 1850-54, proved that ships might pass from the Atlantic into the Pacific by threading the Arctic waters washing the northermost shores of North America, and that Nordenskjold, in 1878-79 was able to complete a kindred voyage along the frigid coasts of Europe and Asia thence to the Pacific Ocean, nothing more than scientific interest has since been centered in these regions mainly because barriers of ice interpose more or less at all seasons to make progress there too hazardous, tedious, and uncertain for the bustling craft of commerce bent upon reaching her destination with dispatch. Further, marine underwriters, knowing the risks to be run, would not have insured either the vessel or her cargo. Therefore, oversea traffic has followed for generations longer and, withal, safer routes. But what has been done in the past is not necessarily a conclusive guide for the future, and Simon Lake proposes taking advantage of those northern waterways which have heretofore excluded the average mariner.

True, the longest way round is at times the shortest, allowing for circumstances that otherwise might occasion delay. Let us see what this actually means so far as separating distances are concerned. Suppose, for example, that the object is to carry goods from New York to Cape Nome, Alaska, and then to bring back a return load to the American Metropolis. The trip, outbound, via the Panama Canal, would mean a voyage of 7,945 nautical miles. To reach the same Alaskan port by way of the Arctic Ocean—entering the Pacific by Bering Strait—the run would be 6,660 knots, a difference of 1,285 miles, or 2,570 knots in a round trip. Again, imagine a steamer bound from Liverpool to Nome. Today, if she goes through the Mediterranean, using the Suez Canal to reach the Indian Ocean, and thence into the Pacific and northward off the eastern shore of Asia to Alaska, she must trace a route 13,705 miles long, whereas 9,280 miles might be saved on a single run if she could make the voyage through the Arctic Ocean! Of course, the journey could be shortened 1,715 miles by crossing the Atlantic, using the Panama Canal and thence up the west coast of North America, but this would still be 7,565 miles more of a run than the route through the northern waters. It calls for no stretch of the imagination to visualize the time and the money that might be saved by abandoning the established lanes of deep-sea transportation.

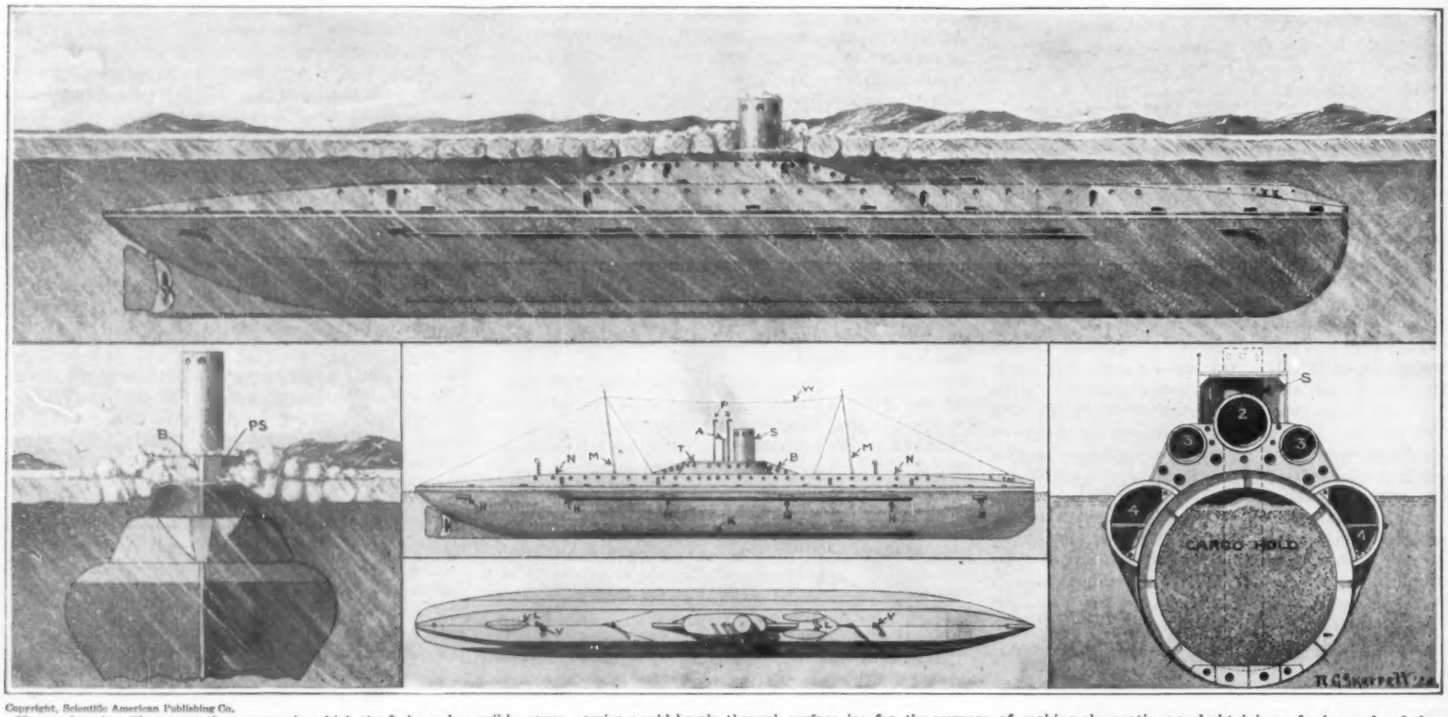
The practicability of the northern route is founded upon data furnished by well-known Arctic explorers and upon Mr. Lake's own experience some years ago with a submarine torpedo boat which he sold to the then Imperial Government of Russia. During the severe winter of 1903-04, the craft in question was operated in Narragansett Bay, and on several occasions she was run beneath heavy floes of ice. To facilitate maneuvering of this sort, the submarine was equipped with an overhead skid or guard which made it an easy matter for her to skate, so to speak, on the nether surface of the overlying ice.

According to information furnished Mr. Lake by such men as Scott, Nansen and Steffanson, and confirmed by Nansen in his well-known book, it seems that ice in the Arctic Ocean does not exceed a vertical thickness of more than 14 feet in the winter season, and fields of ice are never more than 25 miles across before there occurs a stretch of open water. In the summertime it has been the watery breaks and the presence of slush ice which have hampered the Arctic traveler—neither walking nor paddling being possible except under extreme difficulties. These are the physical conditions which Mr. Lake counts upon turning to his advantage. His intention is to operate his submarine cargo carriers in the summer months when the ice has broken up and become more or less rotten. It is said that icebergs do not prevail in that area of the Arctic Ocean contiguous to Siberia and North America and they probably would occasion trouble only when traversing Baffin Bay and the approaches to Hudson Bay. These, of course, would be seen and avoided while at the surface. The purpose of the submarine is to under-run ice jams, wide and solid floes, and not to dive beneath bergs.

The submersible freighter planned by Mr. Lake would have an overall length of 395 feet, a molded beam of 45 feet, and a molded depth of 42 feet, displacing, when fully submerged, 13,000 tons. Under water, the vessel would be driven by electric motors, drawing their energy from storage batteries, giving a speed of 3 knots an hour; and on the surface the propelling mechanism would be an engine of 1,500 indicated horse-power functioning a single screw. This engine may be either a turbine or an ordinary marine reciprocating type using steam or, possibly, a heavy-oil Diesel motor. In any case, the surface speed would be 10 knots an hour.

While the idea is to travel submerged in contact with the under surface of the ice, the boat would

(Continued on page 164)



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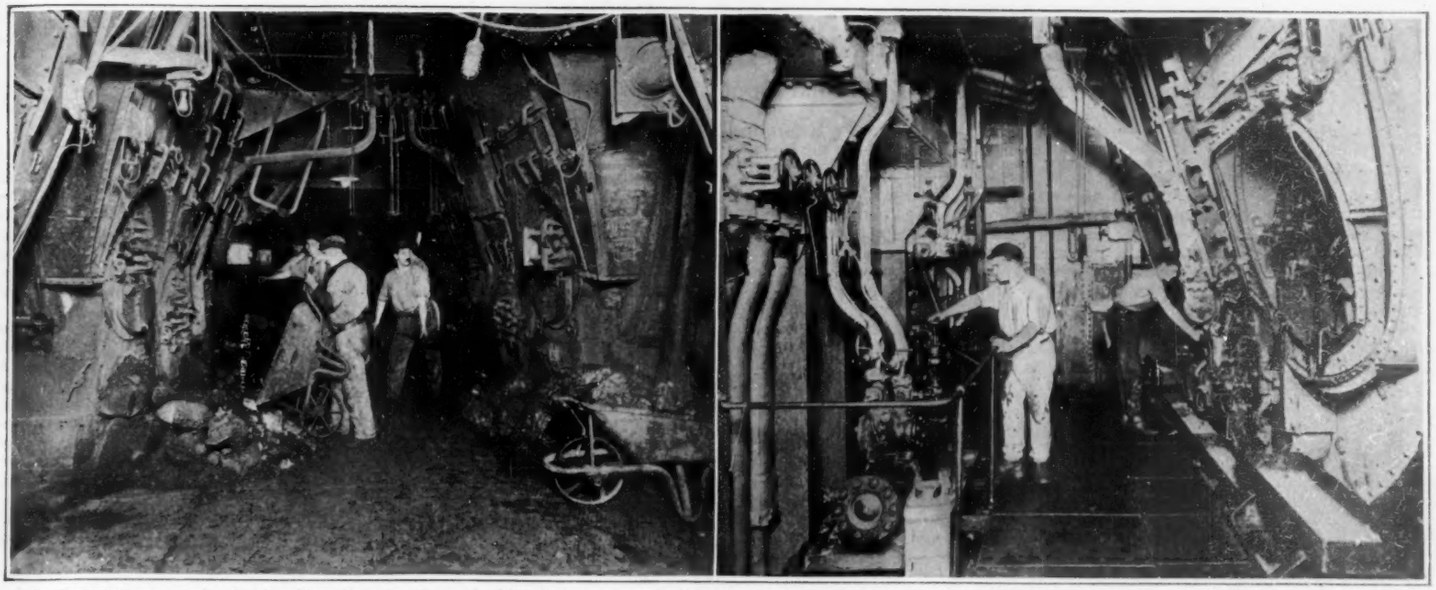
Upper drawing illustrates the manner in which the Lake submergible cargo carrier would break through surface ice for the purpose of making observations and obtaining a fresh supply of air. Lower left-hand sketch shows how the Lake boat would plow her way through rotten ice without resorting to submergence. *P S* are the plowshare-like forward sides of the conning tower designed to turn the ice aside which is first broken by the stout steel rib, *B*. Lower right-hand sketch is a cross-section of the submarine freighter amidships. 1, Non-watertight shelter house. 2, Central control station and buoyancy tube. 3, 3, Passageways and buoyancy tubes. 4, 4, Side buoyancy tubes and oil tanks. Lower central drawings give plan view and outward elevation of the freighter. *A*, Air intake. *B*, Ice-breaking rib. *H, H, H*, Hydroplanes or diving rudders. *K*, Bilge keel. *L, L*, Collapsible life boats. *M, M*, Masts which are lowered to the deck when running submerged. *N, N*, Superstructure. *P, P*, Periscopes. *S*, Elevating steerman's station and air intake which can be lowered level with top of conning tower. *T*, Conning tower. *V, V*, Ventilators. *W*, Wireless.

The submarine freighter designed by Simon Lake for traversing the Arctic ice fields for the purpose of shortening ocean distances



Left: Single boiler room, showing the old method of coaling and raking the boiler fires. *Right:* Single boiler room with the new oil-burning equipment, showing the oil fuel unit and furnace fronts

The old and the new boiler rooms aboard the "Aquitania"—an interesting study of the application of oil as a fuel

The "Aquitania" as an Oil Burner

The Advantages in Economy and Operation of Oil Over Coal Firing

THE "Aquitania" was the third of the big liners of 900 feet length and over to be placed upon the Atlantic route prior to the war, the other two being the "Imperator" (1913) and the "Vaterland" (1914) now the "Leviathan." The "Aquitania," 901 feet in length and driven by turbines of 60,000 horse-power, left Liverpool on May 30, 1914, on her maiden voyage, and covered the distance to New York at an average speed of 23.1 knots, the return trip being made at a speed of 23.45 knots. At the outbreak of the war, she was converted into an armed cruiser for patrol duty. She then did duty as a hospital ship and subsequently as a transport in the conveyance of American troops. Subsequently to the armistice she was used in the repatriation of troops, after which she once more took up her regular work as a passenger ship.

At the close of last year she was withdrawn from service and sent to the Armstrong yard for a thorough reconditioning, and for the reconstruction of her bunkers and the installation of the necessary plant to enable her to burn oil fuel in place of coal. After eight months out of service the "Aquitania" recently made her first visit to this port, which she reached on the day when the "Resolute" and the "Shamrock" failed to race because of the rough sea which prevailed off Sandy Hook. The accompanying photograph was taken from the Committee boat while the two yachts were reaching out past the "Aquitania" to the lightship. It serves to show that a rather nasty sea was running.

The change from coal to oil involved the reconstruction of the coal bunkers to enable them to serve as oil tanks. To this end the bulkheads were stiffened and all joints were made oil tight. "Wash" bulkheads were fitted to prevent surging of the oil. The side bunkers extend for 370 feet along each side of the ship in the wake of the boiler rooms, and they are generally 18 feet wide. There are also three large athwartship bunkers. All of these have been converted for oil carrying. Also, six tanks in the double bottom have been similarly converted.

The total capacity of all tanks is 7,800 tons. This is sufficient for a round voyage from New York to Liverpool and back, which means that the oil can all be shipped at New York. The tanks are fitted with steam-heating coils for cold weather, except those athwartship, which receive sufficient heat from the boiler rooms to ensure the proper fluidity of the oil at all times.

The system of burners, etc., is known as the White low pressure, after its inventor, Mr. W. A. White. This is the system used in the new installation on the White Star liner "Olympic," as referred to in a former issue of this journal. In this system the oil is sprayed by pressure, no compressed air being used. To prevent the possibility of a shut down, a duplicate set of pumps and heaters has been provided for each group of boilers.

Along both sides of the ship, for the length of the boiler rooms, there extends an 8-inch suction and filling main, and four connections to the filling pipes are provided on each side of the vessel. The capacity is such that the whole fuel supply of 7,800 tons can be taken aboard in 6 hours from a tanker lying alongside. The value of this in shortening the turn-around of the ship in port will be evident.

From the point of view of the marine engineer, the paramount advantage of oil fuel is the reduction of the boiler room force and the prevention of the loss of steam pressure, which occurs whenever fires have to be cleaned in coal firing. The "Aquitania" has 21 double-ended Scotch boilers with a total of 168 furnaces. It was the practice to clean 28 of these fires

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The "Aquitania" as she arrived in New York Harbor, completing her first trip as an oil burner

What Is an Asphalt Road?

Some Facts Regarding the Use of This Material for City and Rural Pavements

IT is a surprise to many persons when they realize for the first time how importantly asphalt enters into their daily lives. For instance, the roof of your house is probably asphalt in the form of prepared roofing, asphalt shingles or "gravel" roofing; if your work is in a factory you will find the boilers and smoke stacks coated with asphalt paint, and if it is an up-to-date plant the floors and stairways are probably of asphalt mastic; the wires of your telephone are insulated with asphalt; the swimming tank where you bathe and the reservoir from which your water comes are water-proofed with asphalt; then when you cross the street, your rubber heels, whose toughness is due to the asphalt they contain, come down with the well-known springiness on a smooth asphalt pavement.

A large percentage of the pavements in America are asphalt pavements—and this includes the paved roads in the country as well as asphalt streets in the cities. Only the engineers who design pavements and the contractors who lay them know how difficult it is to construct a pavement that will stand up under the tremendous traffic of today, when loads of fifteen tons are not uncommon. Every imaginable material has been tried—stone, gravel, wood, concrete, brick—but the majority of city pavements laid today are asphalt pavements of the well-known type.

Most persons have a very hazy idea of what an asphalt pavement is. Generally speaking, there are three kinds of asphalt pavements. The one most usually found in cities where the traffic is very heavy is known as sheet asphalt, which, as the name implies, resembles a smooth sheet laid over the roadway. Although it is an "asphalt" pavement, asphalt itself is only a small part of the pavement, though the most important.

The pavement is built by laying first a foundation consisting usually of about six inches of concrete, though a bituminous, an old brick pavement, or an old macadam road makes a good foundation or base. On this foundation the asphalt mixture is laid in two courses; the first, or binder course, consists of a mixture of hot asphalt, sand and broken stone, mixed in a special asphalt plant, hauled to the street, then raked out and rolled with a heavy roller.

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Succeeding in Railway Mechanical Engineering

A Profession Which Offers Exceptional Opportunities to the Trained Mechanical Engineer

By Raymond Francis Yates

RAILWAY mechanical engineering is a special branch of mechanical engineering necessitating a college training of from four to six years. It is a profession that has a larger following in the United States than in any other country in the world, due to the extent of our railway systems. This means also that there is a greater future for the railway mechanical engineer in this country than in any other. America's wealth has been made possible by her railroads; her future depends largely upon them. The young man entering this field can feel that he is associating himself with a stable profession that will give him any future his ability and capacity justify. It is a field in which big deeds are possible and one in which big deeds are recognized.

The author is enabled to outline the field of railway mechanical engineering through the kind and unselfish assistance of a man who is well known in the field but too modest to be quoted. This man has been in a position to survey this field for a number of years, and what he has had to say regarding it can be taken as good, sound advice. If more young men would heed the advice of successful men in the field they contemplate entering, there would be more successes in life than there are at the present time.

It has been the custom of the writer in the previous articles of this series to outline briefly the importance of each engineering profession to the welfare of the country. There is no profession, of course, that is *the* most important. All of them are important, but some of them are relatively more important than others.

It has been stated previously that the wealth of the country has been largely developed through the agency of the railroads. The prosperity of the country then depends to a very great extent upon the efficiency and economy with which its transportation systems are managed. This, in turn, depends largely upon the railroad mechanical engineers who, in a way, stand guard over the largest and most perfect transportation systems in the world. The railway mechanical engineer renders service of the most valuable nature in improving the design of cars, locomotives, etc., in the general interests of operating efficiency and economy. It is through the honest efforts of these men in the past that we have the most powerful, fastest and most efficient locomotives in the world. Few stories of industrial development and progress have more romance, more daring and more interest in them than that of the railroads of the United States.

NO field is more fascinating to the average young man than that of railroading. There is a spirit of action abroad in all fields of railroading, whether it be in the running of trains, dispatching, sorting out cars in the yards, repairing the rolling stock, or even in the offices where the entire business of railroading is boiled down to so many figures on the leaves of the ledger. In the present article Mr. Yates has to do with the work and the opportunity of the railway mechanical engineer. Few fields offer greater inducement to the technically trained man than this profession; for after all is said and done, the railroads are the very arteries of any nation and railroading is the one essential work of all time. The present article is one of a remarkably complete series of articles appearing regularly in these columns and having to do with the opportunities in various trades and professions open to ambitious young men.—THE EDITOR.

What must the training of a successful railway mechanical engineer be? The length of time that an engineer must spend in training varies. In the ordinary case four years of intensive college training will suffice. The length of time that a man should take for education along this line depends to a great extent upon the size of the road with which he expects to follow his profession. If it is a small independent road, probably the four years' training will equip him to master easily all the problems it may present. On the other hand, if he contemplates a more successful career and wishes to become connected with one of the larger railroads of the country, more time must be spent in preparatory work. In fact, some of our better engineers have spent years in training, supplementing their college courses with several years spent in the shop and designing room. A few have made short cuts and have attained their title within a few years; but a man cannot really call himself a thoroughly trained railway mechanical engineer until he has spent some time gaining practical experience in the railway mechanical department. It is here that he gets his first really thorough understanding of the construction and maintenance of the equipment. Although a few of our large colleges are fairly well equipped for the teaching of this profession, none of them is able to construct locomotives, box cars or other rolling stock; experience along this line must be gained with large manufacturers such as the Baldwin Locomotive Works or the American Locomotive Works. It is also possible to gain this experience in some of the good repair shops of the railroads where equipment is being continually overhauled and repaired.

The gentleman interviewed informed the writer that there have been many successful railway mechanical engineers who were self-trained. These men have proved beyond all possible doubt that there is a future for the man who cannot go to college and yet who has a desire to succeed in this particular field. The men in question possessed marked mechanical ability and this was probably their greatest asset. This, combined with the opportunity of associating with engineers and a continuance of home study, secured for these men practically as much technical knowledge as the average college graduate possesses.

The need for mathematics in this profession is about the same as in general mechanical engineering. The problems met are of the same general nature. Of course the study of higher mathematics is necessary, as there is no room for the rule-of-thumb man in this field. Too much depends upon a locomotive to have the design of its parts decided upon without calculation of the most accurate nature. If the connecting rod or crank pin of a locomotive traveling at high speed breaks a catastrophe generally follows in which many lives may be lost; and every railway mechanical engineer must feel the responsibility that rests with him. The writer mentions mathematics only for the benefit of the man who has decided upon training himself as he usually looks upon this as the most difficult thing he has to accomplish.

One of the most necessary qualifications for a young man entering this special field of engineering is natural engineering ability and initiative. It is not exactly a vocation for the admirer of "white shirt professions." A man entering this field has to be a worker, one who is not afraid to dirty his hands and get mussed up out in the shop, as this is all part of the training. A locomotive is not a clean thing to play around, and during the shop experience of the engineer a certain amount of this work is essential. Second in importance to natural engineering ability, a young man must have a fair supply of determination. Of course determination is necessary for success in any field but not of this particular brand. A man must have determination in this field in order to get "those high up" to adopt his recommendations. This requires faith and no little perseverance.

The salary of a railway mechanical engineer is a difficult thing to state definitely. It depends upon the size of the railroad. Of course the larger roads have more money, require greater talent and are willing to pay for it. About the best salaries that are being paid at this time are in the neighborhood of $6,000 per year. They range anywhere from $2,000 to this figure. Of course, the writer does not mean to infer that $6,000 is the absolute limit for a man of exceptional ability. The American Association of Engineers recently made some very definite recommendations regarding the salaries which mechanical engineers of this type should be paid.

A word about the future of railway mechanical engineering. Of course this depends entirely upon the development and progress of our transportation systems and one who realizes how this has gone forward in the past need have no concern about its future. The railroads of this country simply have to keep growing. There is a very good future for this profession as the increasing costs will make it necessary to incorporate greater refinement in locomotive and car design. This will create a demand for men who are capable of a higher quality of engineering work than was thought necessary in the past. In other words, during the past the railroads were not so much concerned with minute details of efficiency as they will be in the future. This makes the field more promising for the man with extraordinary ability and unusual training. It will call for the best there is in men with higher engineering talent.

Very few, if any, railway mechanical engineers go into business for themselves even in a consulting practice. In fact they would not have many people to consult them as the big railroads have engineers of their own and do not find it necessary to go outside of their own organization for advice. Most engineers consider that their first connection with a railroad is only a stepping stone to something higher up. There are many positions on a railroad for which an engineer may qualify. There is the position of mechanical superintendent, superintendent of motive power and other good and remunerative positions in the operating department.

With the great importance and extent of our railroad systems in this country the reader will probably be surprised to learn that only two or three of our colleges offer really worth while special courses in railway mechanical engineering. In general these courses are about as satisfactory as most of the other engineering courses. This is not saying that they are perfect by any means, and probably the next few years will see a marked improvement in the training offered along this line.

What course should the young man follow who desires to become a mechanical engineer and who cannot enter college? In general it can be said that there is a fair chance for any young man to become a self-trained railway mechanical engineer. There is probably more chance in this field than in most technical professions.

First, a position should be obtained in a railway repair shop or in the shops of one of the large American locomotive manufacturers. This work will bring a man into daily contact with locomotives of all types and he can see them being taken apart, repaired and assembled. If he uses his eyes, his head and a note book the most valuable part of his education can be obtained in this manner. Aside from this, a study of general mechanical engineering should be followed. This can be followed as a night course in a local school or as a correspondence course. There is still hope for a man unable to take up either one of these courses. Intensive study of the subject will eventually bring success although it will require a greater length of time.

Utilitarian Fruit Wrappers

THE fruit wrapper, first used in Pacific coast fruit industries, for many years had a prejudice to live down in the East. The East still typically sends apples to market unwrapped. The Eastern idea has always been that wrappers for fruit were a superfluous luxury, and though the Western wrappers are now taken as a matter of course, it being apparent that they are an established thing, there is still little appreciation of their utilitarian value.

Any fruit wrapper tends to prevent decay, as the individually-wrapped orange, pear, apple or lemon has a measure of protection from outside. As the wrapper has come into extensive use, moreover, there has been great improvement in wrappers.

The consuming public little realizes it, but much of the high class Pacific coast fruit it eats is prevented from decaying in transit by chemical agents in the fruit wrapper used. Not any paper will do for a wrapper, but a special fiber wrapper chemically treated to do quick, efficient work when the fruit is bruised. Decomposition, as is generally known, starts with a bruise. The effect of the special wrapper is to cling close, dry up the escaping juice, harden the spot and kill bacteria.

Fruit wrappers are doing this thing daily, not occasionally but in innumerable cases. The economic loss averted is enormous. Fruit wrappers are not a commentary on a civilization given to super-refinements of luxury, but to a race careful to stop the small leaks.

Electrification in Brazil

How the Sao Paulo Railroad Is Following the Example of Its American Namesake

By Robert Carlton Brown

THE recent announcement of the forthcoming electrification of a portion of the lines of the Paulista Railway in the State of Sao Paulo, Brazil, has aroused great interest in railway and electrical circles of South America, the United States and Europe. The electrification was decided upon only after the company had made an exhaustive investigation of its possibilities. Simultaneously with the announcement of the letting of the contract, work on the manufacture of equipment for the great enterprise was begun in the United States.

The initial enterprise on the Paulista Railway will extend over a line forty-four kilometers in length from Jundiahy, the southern terminus of the Paulista Railway, northward to Campinas. The railway is double-tracked over the whole of this distance.

This installation calls for twelve electric locomotives, eight locomotives for freight service and four locomotives for passenger service. The freight locomotives will weigh ninety metric tons each and the passenger locomotives 110. These locomotives will be operated at a tension of 3,000 volts of direct current. They will take their power from two overhead copper trolley wires by means of a pantograph operated by compressed air. These locomotives will each contain four motors connected with the locomotive driving axles by means of double-spring gears and pinions. The locomotives can be controlled by one man with the ease that a street car is operated.

Electric power will be furnished to the railway by the Sao Paulo City power company, which will deliver three-phase, sixty-cycle power at 88,000 volts. It will be distributed along the lines of the Paulista Railway for connection at the various power substations which will be eventually installed. For the operation of the electric locomotives over the initial section, a power substation will be installed midway between Jundiahy and Campinas.

This substation will convert the 88,000-volt alternating current into the 3,000-volt direct current for delivery to the overhead trolley wires. The equipment for this substation, which will have a total capacity of 4,500 kilowatts, will include a system of three motor-generator sets of a capacity of 1,500 kilowatts each. These will consist of 2,300-volt, three-phase, synchronous motors, directly connected to two 1,500-volt generators. These will operate in series and will give the potential strength of 3,000 volts required to operate the locomotives on the line.

There also will be included with each motor-generator set, and mounted on the same shaft with the motors, an exciter which will provide excitation for the two generators. The 88,000-volt current which enters the substation is stepped down to 2,300 volts for connection to the motors by means of transformers. A switchboard with automatic switching equipment and meters also will be provided for measuring the current which enters the station as well as that which is delivered to the trolley system. These automatic switches will be so designed as to provide the maximum protection to all apparatus as well as to the operators against any possible accidents. The lines will be further protected against lightning by means of electrolytic lightning arresters. The trolley wires will be supported by means of the well-known catenary type of overhead suspension, especially developed for high voltage, heavy traffic and high speed service. The steel rails used for the present system of steam locomotive service will be connected by means of copper bonds to establish the return circuit.

Materials for the new work will begin to arrive in Brazil from the United States within a few months and the railway company will immediately begin work on the electrification, assisted by engineers of the electric company. The installation of the power transmission lines and the overhead trolley system will be started first. Work will also be started at once on the first substation and it will be ready to receive the machinery on its arrival. The huge locomotives will be the last of the equipment to arrive. These will be unloaded at the port of Santos. They will be assembled there and will proceed to Jundiahy over the rails of the Sao Paulo Railway. It is expected that the electrified system will be in complete operation by July, 1921.

One feature of the electrification will be that the direct system of current will be used instead of the usual alternating current. The locomotives to be used will be provided with the regenerative braking system, whereby the locomotives and the trains when descending a grade generate power which is returned to the line. The speed of trains descending grade can be very accurately controlled by this system and at the same time power is being generated. Further advantages of this system include elimination of difficulties incident to the use of the airbrakes on heavy freight trains when descending grades; elimination of brake-shoe and wheel wear with resultant reduction in maintenance; reduced wear on tracks, especially on severe curves; and entire absence of grinding of the brakes which is especially disagreeable on a heavy passenger train.

Economy is the big factor in favor of electrification of railways, although there are many other arguments to be advanced in favor of the replacement of steam locomotives by the electrical equipment. The high cost of coal has always been a leading item in the expenses of the railways of Brazil and it is believed by many observers that the coal question will eventually result in the electrification of most of the railway systems of the republic. Electrification is peculiarly practical in Brazil in view of the great abundance of waterfalls. Excellent waterpower is easily available to a large portion of the railway area of the country.

Experts of the electric company who are in Brazil on the Paulista enterprise summarize the advantages of electrification under two leading heads. One of these

(Continued on page 166)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Seeing in the Dark

To the Editor of the SCIENTIFIC AMERICAN:

In the article, "Detecting Men by Their Heat Radiation," in your issue of March 27, 1920, it is stated that my instrument "can detect the difference between the painted and unpainted sides of a steel plate, of which the temperature is slightly higher than the surrounding atmosphere."

The interesting fact is that on *clear nights* the instrument readily detected the difference between the painted and unpainted sides of an invisible steel plate which had the *same* temperature as the surrounding atmosphere. And, furthermore, the side of the plate which was painted black gave an indication similar to that which would have been given by a body considerably warmer than the atmosphere, although there was no question of the fact that the entire plate was at the same temperature as the surrounding atmosphere. This result was in direct contradiction to what had been predicted from previous laboratory tests on a *cold* body, in which the blackened metal gave a considerably *colder* indication than that given by the unblackened part (both parts being of course at the same temperature). An analysis of these laboratory results led to the conclusion that the large cold indication of the blackened surface was, of course, a measure of the true temperature of the metal, while the warmer indication of the bright metal was caused by reflected energy from the walls of the apparatus which were at the higher temperature of the room. This unexpected result seemed entirely to negative my method and I took care that news of it did not get to Washington until I had made some actual field trials. Many authorities held that the radiation from objects such as men would be entirely obscured by the effect of the surrounding atmosphere and the background, and this laboratory test was held to support their view. However field tests showed that I was right and they were wrong, and resulted ultimately in the very successful results alluded to in your article.

I might add that the reason for the cold indication of the bright metal when in the open, on clear nights, was reflection of the intense cold of interstellar space, or stated more correctly, a cooling of the blackened surface of the thermopile by radiation into space. It was this fact that rendered it so easy to detect aircraft on clear nights, as the plane, coming between the instrument and the outer sky, acted as a shutter to stop this radiation into space, and resulted in giving a large warm indication.

San Francisco, Cal. SAMUEL O. HOFFMAN.

Cleaning the Clock

To the Editor of the SCIENTIFIC AMERICAN:

As a reader of your publication for more than thirty years, twenty or more of which have been spent in the repairing of all kinds of time-pieces, I wish to protest against the printing of such ideas as those contained in a recent article on the use of kerosene as a cure for dirty clocks.

The oil used on clocks is as near non-drying as is obtainable but even the best will dry up somewhat after the long time between cleanings. As there is less than two drops on the whole outfit of pivots in the ordinary type of clock it can be easily seen that the supply is small and not renewed from oil-cups as in many other types of machine. Also the clock is more or less open to the air around it which has a great deal of dust floating in it ready to stick to anything fluid like the oil around the pivots. This tends to thicken the oil and to work into pivot-holes, serving as an abrasive to cut the pivots.

The only way to relieve the condition is to take the clock completely to pieces and clean each and every piece; to "peg out" each hole; polish the cut or worn parts and then to assemble the whole for proper oiling on clean metal.

The use of kerosene on a tuft of cotton is as much good in the manner given in your article as it would be in removing carbon from the cylinder of an automobile by placing a cloth wet with the "panacea" on the floor of the garage under the machine.

Newton Center, Mass. F. W. WOOLWAY.

Measuring the Flow of Liquids

To the Editor of the SCIENTIFIC AMERICAN:

In the June 19th issue of the SCIENTIFIC AMERICAN we notice a description of instruments for measuring and recording the flow of liquids, recently brought out by a large British firm.

The description is so exact that we have no difficulty in recognizing this as the device originated by Mr. Lea, mechanical engineer of Manchester, and the only reason of our writing to you is because of the inaccuracy of the statement that this has been recently brought out.

As a matter of fact our clients have been the American manufacturers of this instrument on which they hold several patents on improvements since 1911. We know that several thousand of these are in use in many of the largest plants in this country, Great Britain and other parts of the world.

The device is not new but is a well-established and time-tested device.

Philadelphia, Pa. R. G. E. ULLMAN.

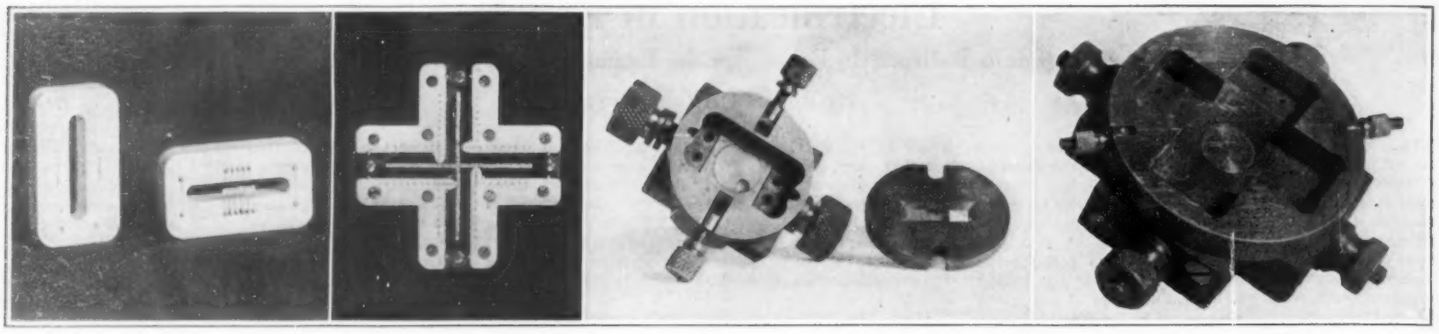
Invention vs. Re-invention

To the Editor of the SCIENTIFIC AMERICAN:

Your article, "A Boat That Pumps Its Way Along," in the issue of the SCIENTIFIC AMERICAN of June 12 and the illustration of the same is certainly another proof, as you say, that "history is forever repeating itself." The principle involved in the propulsion of this boat is identical with that James Rumsey used about twenty years before the "Clermont" went up the Hudson. Of course he had none of the fine mechanism of modern times, but the boat was propelled by taking in water near the front of the boat and expelling it in the rear. Undoubtedly this was the first application of steam to navigation. Recently the state of West Virginia has erected a beautiful monument overlooking the point in the Potomac River at Shepherdstown, West Virginia, where the first demonstration was made by Rumsey December 3, 1787. No one will claim that the old "Constitution" is anything to compare with the modern dreadnought, and, of course, Rumsey's crude beginning is in the widest contrast between the modern floating palace, but honor to whom honor is due.

THOS. C. MILLER.

Shepherdstown State Normal School.



1. Thermopile used for trench purposes, one-half actual size. 2. The "cross-hair" thermopile used in the aircraft detector, about one-half size. Note the elaborate construction. 3. Heavy metal holder for the trench thermopile. 4. The massive holder for the "cross-hair" thermopile.

Thermopiles and holders for trench purposes and for detecting airplanes in the dark

Seeing in the Dark

An Account of the Success Obtained During the War in Detecting Invisible Objects by Their Bodily Heat

By Samuel O. Hoffman, formerly of the Science and Research Division, United States Army

WHEN in the early years of the war the horrible nightly Zeppelin raids commenced, attention of engineers all over the world was directed toward finding a means of combating this menace. The time of occurrence of these raids, always at night, suggested the solution of the problem. Remove the enshrouding darkness and the raiders would fall easy prey to artillery fire and the fast combat planes. As the war went on and degenerated into the deadlock of trench fighting a much greater need arose for the same device. Trench warfare was almost entirely a matter of night activity. Scouting and patroling, raiding, wiring, and other work was done almost entirely under cover of darkness. Although at night the front was a beehive of activity, any circulation in daylight, even far in the rear, quickly drew enemy fire.

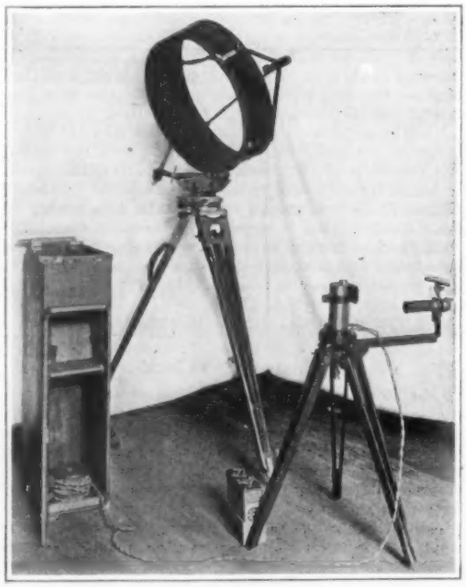
It can be thus seen that an urgent need arose for nothing less than a *sixth sense*, a means of seeing in the dark. It is apparent that if either side had had such a device they would have had a preponderating advantage, and, at the very least, trench warfare would have been profoundly modified. Curiously enough, results have shown that such a device *is* practicable, and it was in fact subsequently worked out, although too late to be used in trench warfare.

The question will be asked, Did not flares and star shells supply this need? Emphatically not. In the first place, they were equally available to either side. They gave only intermittent illumination; and the enemy, caught in the glare of a star shell, knew he was under observation and by remaining motionless could escape detection. Moreover, these methods were useless for detecting aircraft at night.

For a number of years prior to 1915, the writer had devoted the greater part of his time to investigations involving infra-red radiation, and his familiarity in this field immediately suggested that here was the solution of the problem. This radiation is the ordinary dark heat such as is felt on bringing the cold hand an inch or so in front of the face. While of the same general nature as light, it has quite different properties. Hardly any substances are transparent to it, rocksalt being the only one easily obtainable. Glass is particularly opaque, so that ordinary optical instruments are useless. However, sharp images can be easily formed by using concave mirrors of ordinary dimensions, as the actual wave length of this radiation is sufficiently small (1/2500 inch) to obviate trouble from diffraction. This is the reason for the great superiority of this radiation over sound waves for detecting purposes in the dark, for with any available sound waves (in air) it is possible to form a sharp image only with monstrously large apparatus.

By the middle of 1915 the problem was pretty well formulated, the amount of energy available was calculated, and it seemed certain that the whole idea was practicable. Attempts were made to interest several branches of our own War Department, the British War Office, Admiralty and Inventions Board, and several other agencies. Almost everywhere the idea received attention and courteous replies—and nothing more. Ideas were at a discount. What was wanted was developed apparatus.

A year or so went by and the early part of 1918 found the author in New York with two weeks' unofficial permission to show what could be done. It was easily demonstrated experimentally that there was a large amount of dark radiation available, and that the detection of this radiation would not require very delicate instruments. These experiments were made indoors with a warm body, and as an afterthought the device was tried with a cold body, with apparently contradictory results, for the indicating instrument moved in the opposite direction to that expected. A quick analysis showed the reason for this to be reflection from the walls of the room, and it seemed that this fact would render the device inoperative in the field. The apparatus was hurriedly reconstructed, and



The complete instrument for detecting men in the dark, set up for use. The large tripod carries a 24-inch parabolic mirror, with the thermopile in focus. The small tripod holds the indicating galvanometer

Complete outfit for enabling soldiers to detect the enemy in pitch blackness

the following night a test was made on the roof of the laboratory. The result was a complete vindication. Every object sighted on gave a definite indication, some being several hundred feet away. These results were of more value as the mirror used was only 4 inches in diameter, the largest that could be found in New York. Shortly after this roof test official permission was given to continue the work.

The apparatus used in these tests was as follows: A concave mirror was used to concentrate the infra-red radiation on the blackened surface of a thermopile, which consisted of minute wires of bismuth and silver soldered together. The radiation concentrated on this blackened junction was absorbed, heating it slightly. The resulting electric current, flowing through a galvanometer, indicated when the apparatus had spotted something warm. It can be seen that this apparatus was very simple, extremely rugged and portable. Aside from some dry cells to operate the galvanometer lamp, no source of power was required. A potentiometer was necessary to make the device practicable, as it usually happened that the background was a different temperature from the surface of the thermopile, and it was necessary to compensate for this.

During the next few weeks trials were made almost nightly with all sorts of backgrounds and weather conditions. The results were uniformly successful. Men could be detected with startling ease when 600 feet away. The effect on the apparatus was the same whether they were crawling slowly or running rapidly. To simulate a sentry looking out over No Man's Land, a soldier lay in a depression in the ground and lifted his head from time to time. He was detected unfailingly as soon as his head appeared above ground, although at a distance of 400 feet and absolutely invisible to the eye. The murderous possibilities of such a device attached as a sight to a machine gun and trained on men in the dark can be imagined. Ranging the instrument in front of and parallel to our front line would constitute an arrangement for preventing raiders from creeping into our lines undetected.

A report of these results was immediately sent overseas, and, anticipating a favorable reply, the standardization and construction of the apparatus was rushed. Navy searchlight mirrors were used, cut down to two-thirds of their original diameter, thereby obtaining a good optical figure. The mirrors were silvered on the surface, and though they tarnished rapidly, this did not seem to affect the sensitivity and rendered the mirror less conspicuous in the glare of a searchlight. The design and construction of the thermopiles took several months. There was no bismuth wire available in this country, the product formerly coming from Germany. The making of this was immediately attempted, and pliable wire about the diameter of a human hair was successfully produced. About 40 different designs of thermopiles were tried out before a satisfactory design was obtained. This work, all done by enlisted men in the Army, was very tedious. It was necessary to work under a binocular microscope, using special tools. It is interesting to note that no thermopiles of the final design have ever broken in use. So sensitive were these thermopiles to changes in temperature that it was necessary to shield them very carefully from drafts and sudden temperature changes. The enclosing case was made of very heavy metal, the radiation entering through a narrow slit which was covered with a plate of polished rocksalt. The rocksalt had a slight coating of varnish to protect it from the moisture in the atmosphere. Special galvanometers were constructed, and the whole apparatus was extremely compact and self-contained.

About the time this work was finished, a cable arrived from general headquarters of the A. E. F. asking for immediate shipment of the device for test at the front. It went overseas in August, 1918.

So far particular attention had been given to the use of the device in trench warfare. By this time,

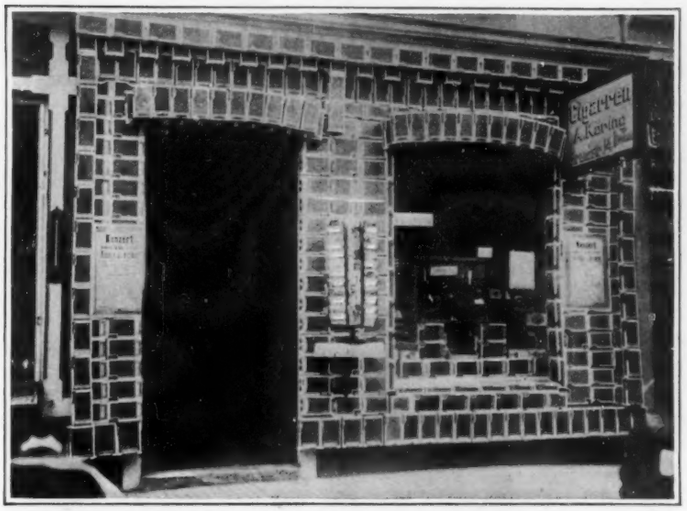
(Continued on page 166)

A Store Front of Cigar Boxes

IT is peculiar to study the impressions that persist year after year regarding various peoples, and that are never revised despite the ever-growing evidence that such impressions are erroneous. For instance, and this is the case in point: The Germans have the reputation abroad of being anything but original and inventive. We regard them as a very thorough and painstaking people, ready to adopt and improve upon any idea which they come across, but not as originators. However that may be, there is daily proof to the effect that the Germans are highly imaginative and original in their own way.

Perhaps it is an aftermath of the war, but at any rate the Germans have been displaying unusual ideas in the field of advertising and publicity of late. Recent expositions in Germany have brought forth almost no end of ingenious publicity "stunts," proving once and for all that the Germans are creative along certain lines.

The accompanying view offers an example of this German ingenuity. Here is the store front of a cigar dealer who, finding business somewhat slow, went to work and built a front out of cigar boxes. This store, situated in Bremen, never fails to attract attention from passers-by.



This Bremen store front covered with cigar boxes never fails to attract the attention of passers-by

A Close-Up of Vesuvius

THE accompanying view of the crater of Vesuvius is due to the risk taken by an American Red Cross worker in Italy. It was taken from a point close above the molten lake of lava surrounding the inner cone of the famous volcano. Every few minutes showers of lava and huge stones were ejected from the cone crater, but through good fortune the photographer escaped unharmed.

A close-up of Vesuvius made by an American Red Cross worker in Italy, at a considerable risk to himself from the showers of lava and huge stones

To Make Asparagus Keep

CUT asparagus exposed to drying winds in the open air will become unmarketable in 48 hours, and of poor quality in considerably less than that time. Cut asparagus handled by a person who knows how—any boy or girl can turn the trick—will keep in marketable condition for 12 days. What is more, it will have gained 50 per cent in weight!

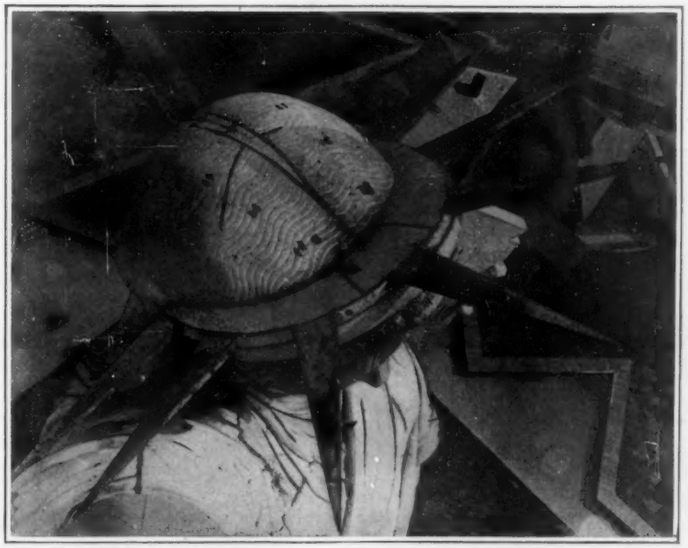
Sounds improbable, doesn't it? But it isn't, having been demonstrated in recent experiments at the Oregon agricultural college. The demonstrations should prove of tremendous benefit to family households, to gardeners, and to retail stores.

There are several ways of handling cut asparagus, of varying degrees of efficiency. Exposure to dry air is the least desirable way; a better way is to place in a moist chamber. In a glass case free from a direct air current, asparagus will not wilt though kept 12 days, and will not lose either weight or length. Asparagus stalks, the butts of which are placed in water, placed in the open air, will keep in good marketable condition for 12 days and will increase somewhat in weight.

The Latest Portrait of the Largest Lady in the Land

WHAT is the accompanying photograph? At first glance it might mean almost anything from a little known variety of shell fish to a new kind of harvester. Even a seasoned New Yorker would not recognize this latest portrait of Miss Liberty—the largest lady in the land.

In order to secure this unusual view of the Statue of Liberty an intrepid photographer climbed out on the torch of the statue and took a photograph looking down on the head. The result is exceptionally striking, and serves to convey an excellent idea of the magnitude of this statue which was brought to this country from France in sections and assembled on its pedestal in New York Harbor. The inside head measurement from ear to ear is exactly ten feet.



Copyright, Kadel & Herbert

Looking down on the head of the Statue of Liberty from the torch—a very unusual view of this well-known structure

Facts About Chinese Eggs

THE standard egg case used in the United States and Canada holds 30 dozen eggs. It is an oblong box, divided into compartments by a partition on either side of which 15 dozen eggs are placed, three dozen to a layer. Between the layers, and between eggs in a layer, cardboard forms an individual safe box for each egg. A cardboard device called the "filler" is universally used.

The standard egg case in China is a two-compartment box in which kerosene, two 5-gallon cans to the box, arrives in the country. The Chinese thriftily reship it filled with eggs. Its capacity is 280, 300, or 360 eggs, according as the eggs are of large, medium or small size. If the eggs are small, the net contents equal those of an American egg case.

The Chinese do not use cardboard "fillers." Instead they use rice hulls, wheat bran, kaoliang bran, or sawdust, and they pack the eggs in regular layers, with skillful distribution of the sawdust or other filling material to prevent breaking. The method is successful. When rice hulls are used, the cost is estimated at about five cents per case.

Facts about Chinese eggs should arouse in Americans at this time much more than a polite interest—for we have been eating Chinese eggs, and Chinese egg products. During five or six years past, large quantities have been exported to this country and Canada, and marketed in large cities. The Pacific Coast is actually worried about the situation, fearing its detrimental effect on the local egg industry. Egg marks acts especially aimed at the Chinese egg, to prevent its being marketed under any deceptive alias, are now operative both in Canada and this country. Chinese eggs can be marketed at a very low price.

The market value of eggs in one Chinese province, Shantung, has risen to such an extent that an estimated three-fourths of the total "lay" is sold by producers. There are 1,500,000 hens in this province, and the average production is 84 eggs per hen. As average production goes, that figure is not low. It has been calculated by Department of Agriculture experts in this country that the average American hen produces little, if any, in excess of 90 eggs per annum. During the past two years, local egg prices have doubled in price in many parts of China, consequent on the export demand, and not long ago quotations reached the dizzy height (for the Orient) of one cent each.

Consumers and poultrymen in this country are naturally most interested in China as an exporter of fresh and preserved eggs. Yet various egg products the ordinary lay reader never heard of account for a much larger percentage of the Chinese production. These egg products are whole-egg powder, dried albumen, liquid yolk, and dried yolk. The exports of yolk in a normal year are calculated to account for over 700,000,000 eggs.

Dried albumen is put up in tins holding 100 lbs. Liquid egg yolk is shipped in barrels holding 430 lbs. net. In addition, large quantities of frozen eggs are exported. These egg products are used considerably in the baking trade.

Why were not Chinese eggs talked of before now? The reason lies in a simple economic condition. It is only within recent years that the level of egg prices in this country has reached so high that financial interests cared to undertake the costs and risk of egg collection in China, shipment thousands of miles to North America, and final sale in this country. The margin existing was not sufficient. With American eggs selling at high prices, however, the situation naturally appealed to the speculator, whose activities have caused such a stir in Pacific Coast egg circles.

Pulp Wood from Labrador

A Paper-Supply Likelihood of the Near Future

By J. T. Rowland

TO a person who is familiar with the northern extension of our Atlantic coast which goes by the name of Labrador, it is always amazing to discover the misconceptions concerning that region, which exist, almost without exception, in the minds even of educated and otherwise well-informed persons. The words "lonely," "remote," "desolate" seem to picture the qualities which the mention of Labrador unfailingly calls to mind, while the association with icebergs and an occasional seal imply an immediate juxtaposition to the North Pole. It follows, therefore, that one is usually met with an incredulous smile when he states the fact that Labrador lies between almost exactly the same parallels of latitude on this side of the Atlantic which the British Isles occupy on the other, and that for all the ignorance which exists concerning it, the coast is literally just around the corner from us—much nearer the northeastern extremity of the United States than Alaska is the northwestern.

Why the coast of Labrador stays cold: One of the many icebergs to be found in the coastal waters

The reason for our lack of knowledge—and interest—is neither the remoteness nor the Arctic aspect of the land, but the simple fact that it produces nothing which we have heretofore thought worth the trouble of going to fetch. "A few poor cod and worse pelts," as one mission doctor summed it up, have made the total of Labrador's contribution to the world's wealth. For this reason the coast has languished in disregard. Poorly chartered, unbuoyed and next to unlighted, with many of its hundreds of bays and inlets actually unexplored and the position of islands and reefs known only to unlettered fisher folk, it is small wonder that the great ships bound out from Montreal pass the coast by with a shudder and are thankful each trip when the Strait of Belle Isle has been left astern.

Some years ago I was discussing with Dr. Grenfell the possibility of Labrador's some day becoming economically useful to the world. We stood on the summit of a hill of rock overlooking beautiful Grosswater Bay, which I could see, in my mind's eye, sheltering a fleet of a thousand ships. "There is nothing in the world to keep people away," the doctor was saying, "except only the fact that there is nothing to bring them. If ever that is changed we shall be swamped!" To the medical missionary who had devoted his life to the people of the coast such a prospect had much in it which was naturally not pleasing; but whether or not Labrador needs the world, the day has come when the world needs Labrador—and what it needs it generally takes.

Climatically Labrador is divided into two regions, the coast and the interior. The former is a few miles wide and is Arctic in character, the latter is a few hundred miles wide and is what one would expect to find in the fifties of north latitude; that is to say, it is well watered, densely forested and quite similar in character to the North Woods—hot in summer and cold in winter. This amazing disparity in climate between two regions so close together is due entirely to the fact that the polar current, setting southward out of Davis Strait, prevents the seaboard from ever growing warm. There is floe ice along shore until late in the spring and there are bergs, though not in sufficient numbers to be a serious menace to navigation, all summer long; and the temperature of the sea water rarely gets far above 32 degrees. Thus, it is the Arctic condition of the coast which is abnormal, if one may use that word of an established natural condition, and it is the north temperate climate and flora of the great interior which is "normal" and as it should be; but the sea coast's forbidding aspect has so long been synonymous for Labrador that it is hard for any one to believe that there can be anything but barren tundra behind.

I shall never forget my own surprise at my first glimpse of the hinterland. We had been for days skirting the coast in one of Dr. Grenfell's hospital launches and had seen nothing but ice and bare rock—not a bush or a blade of grass. At last we swung west around a great headland and started threading our way up a narrow defile between immense hills of a blackish rock. After about a half hour's steaming we came upon a little clump of dwarfed tamarack nestling in a hollow. Then suddenly the vessel turned a sharp corner and we came out abruptly upon the waters of a beautiful big lake, surrounded by gently rolling hills covered to the water's edge by a forest of spruce and tamarack so dense that one could see scarcely ten feet back into it. The air here was warm and the sky overhead blue; we felt as though transported back by some magic to the shores of an Adirondack lake. Yet this was all deep water, easily navigable by the largest ship. Perhaps half a dozen white men at most had ever seen it before us.

This description will fit, with modifications as to distance, the head of almost any one of a nearly innumerable series of inlets and fjords, for the coast is very much indented and looks on the chart almost like the fringe of a rug. Hamilton Inlet penetrates the farthest—nearly 150 miles straight back from a line drawn across the outlying headlands—and its inner half, Lake Nelville, is a veritable inland sea of about the size and shape of Long Island Sound. When I last visited this water its shores were strewn with quantities of saw logs from a raft which had broken up in a storm. This was the aftermath of the efforts of a half-baked Nova Scotia concern. It lacked the equipment to collect the logs, and it did not long survive their loss.

More recently, however, the knowledge that there is behind that forbidding, desolate coast an almost limitless supply of readily accessible wood has begun to attract interest for purposes other than lumbering. Pulp wood is every year more greatly in demand and more difficult to secure. Moreover, timber which is not sufficiently tall or heavy for profitable lumbering is commercially valuable for pulp wood. In many cases this has resulted in denuding forests of their young growth. Labrador is probably the one place on earth where this would do no harm, unless it be to an occasional spruce hen. The country is singularly devoid of game.

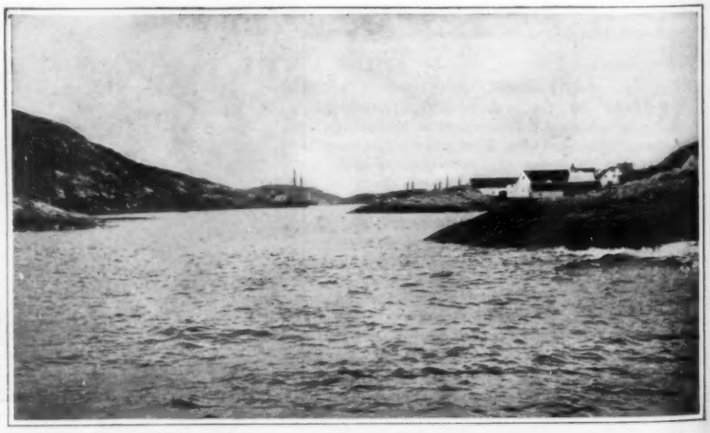
The timber consists chiefly, almost entirely in fact, of spruce (*Picea nigra*) and tamarack (*Larix americana*). In size it runs from a few inches to two feet in diameter at the butt. The farther inland one penetrates the larger the timber grows, but my personal observation has been that two feet is about the limit, except for occasional trees. It grows most abundantly around the heads of inlets and along stream courses. The higher hills are bare, as are likewise considerable stretches of elevated plateau.

Roughly speaking, the northern limit of the timber is in about 57 degrees north latitude. At least I have seen none to the northward of this at a distance some fifteen or twenty miles back from the coast, though at Davis Inlet in 55° 50′ it is abundant. This means that there is a belt of timberland some 400 miles long, north and south, which is immediately accessible by navigable waterways to an average depth of perhaps 30 miles, without counting the great interior basin of Hamilton Inlet. The timber is suitable for pulp wood and is of little or no value for any other purpose.

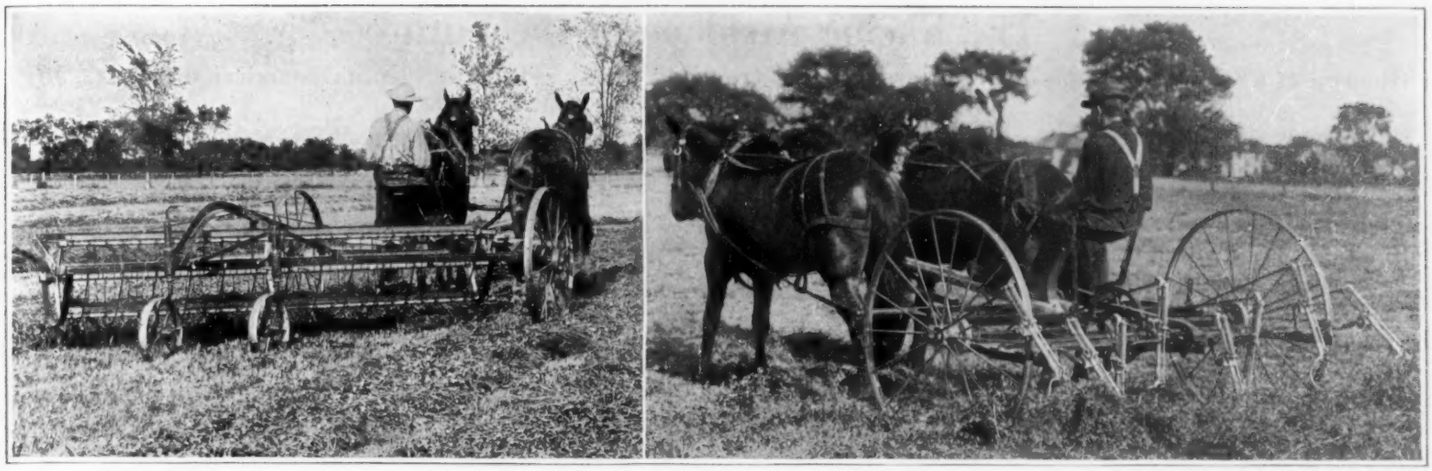
A pulp wood enterprise has already been undertaken upon the Alexis River, on the southern portion of the coast, not far from Dr. Grenfell's hospital and mission post at Battle Harbor. Others will doubtless follow and it may be that the inundation of the "lonely Labrador" by foreign workers is just around the corner of the future if given adequate means and knowledge.

Photographs Courtesy Motor Boating

A bold promontory near Cape Mugford. The peak is 3,000 feet high



Entrance to Battle Harbor, with fish merchants' rooms in whitewashed buildings



Left: **Side delivery rake. Even where horses are used, modern farm implements make work easier for the farmer.** *Right:* **An eight-fork hay tedder**

Harvesting the Hay the Latest Way

By Arthur L. Dahl

THE United States is about to harvest the greatest crop of hay ever produced, estimated at 111 million tons. Lack of farm labor is largely responsible for the record crop, for areas that would ordinarily have been devoted to the growing of food crops were allowed to raise volunteer crops of hay because labor was not available to work the land. The labor shortage is just as acute in this harvest period and the quality of the hay produced will be largely dependent upon the efficiency with which the gigantic crop is gathered and prepared.

Hay making is an operation that must be done in a certain space of time that is short at best and that is always liable to be made shorter by bad weather. For this reason there is perhaps no farm operation in which system and efficiency count for more than in haymaking. Hay has been quite steadily increasing in acreage for a number of years, until at the present time it occupies about one-sixth of the tilled area on farms in the United States, and has an annual value on the farm, unbaled, of over a billion dollars. It has been estimated that the annual cost of harvesting our hay crop, under normal conditions, is about $125,000,000. When we contemplate this enormous amount of money it is easy to see that a reduction of even a small per cent of this cost would add millions to the profits of the hay growers of this country, and according to experts of the Department of Agriculture it is possible for every such grower to make substantial savings by using proper equipment. As a single example of the efficiency of proper implements, it has been demonstrated that one man with a team can turn more hay with a tedder than can 12 men doing the work by hand. In a period of labor shortage and high wages the use of haymaking implements is not only economical but almost necessary.

Hay is the bulkiest crop grown on our farms, and its cutting, curing and stacking require a great deal of power. Efficiency in haymaking, therefore, turns on the utilization of the cheapest and most abundant power. On the average farm tractor or animal power is available in abundance, even though manpower is short. Wasted human labor does not always mean idleness but more often labor expended unnecessarily on operations which are not efficiently planned and carried out.

The first operation in harvesting hay is that of mowing. Here there are a number of factors that make for efficiency and saving. The time of day when the mower is started has a direct bearing on the amount of hay made per day, and the arrangement of the moving crews likewise affects the results. The size of the mower used has a decided bearing on the quantity cut in a day, and other factors enter into the proposition.

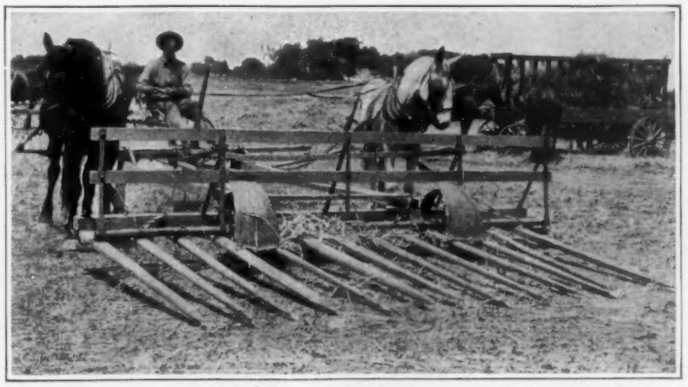
On a great many farms the mower which will make a five-foot cut is used. This size requires the services of a team of horses and a driver, and under average conditions a 5-foot mower will cut 10 acres in 10 hours. Now if that same man and team will operate a 6-foot mower it will cut 12 acres. If the man adds another team to the outfit, or uses a tractor to pull a 7-foot mower, he can cut 14 acres a day, and if an 8-foot mower is used about 16 acres can be covered in the 10 hours. Of course the wider mowers require more power than the smaller ones, but they require no more supervision, and accordingly the labor efficiency in haymaking can be almost doubled by the use of suitable implements. Where tractors are available, as they are on a large proportion of our farms, ample power is provided to operate any sized mower.

In a study of haymaking crews made by the Department of Agriculture, it was found that the same number of men and horses will produce varying results under different arrangements. For instance, where three mowing outfits are used, and all three men work close together, one mower following the other, each cutting a swath, less work will be accomplished in a given period than where each outfit works separately. This is due to two causes. When working close together, if one machine develops trouble and it is necessary to stop, all three mowers must stop, and the lost time is multiplied by three. Furthermore, when men work close together there is a decided tendency to talk, and this interferes with their efficiency. When each outfit is placed in a given field and works alone, better results are obtained, and there is no interference from other machines.

For a long time in the South it used to be the custom, and is yet to some extent, to use a big crew of negro laborers to turn over by hand the curing alfalfa and Johnson grass. In an actual test made in the same field, it was found that a farm boy, driving a team and operating a hay tedder, could turn over as much hay in a day as a crew of 12 negroes using pitchforks or rakes. Even where labor is plentiful and cheap it is not hard to figure out the most efficient method for turning hay. A hay tedder is a simple and comparatively cheap implement and should be on every farm where hay is grown.

Raking hay is another thing that can be done more efficiently by the use of proper implements. On many farms the 8-foot rake, operated by one horse, is used for this operation, but where the area devoted to hay is fairly large, this outfit is costly and inefficient. A 12- or 14-foot rake, drawn by a strong team or a tractor, will cover 50 per cent more ground and do the

(Continued on page 167)



A sweep rake used in the West. This implement is said to reduce the labor by fifty per cent

Shade Trees for City Streets

By Alfred Longville

PROVIDING shade on city streets is as much a municipal function as providing lights or sidewalks and should therefore be cared for by public officials, says one of the horticulturists of the U. S. Department of Agriculture in a recent bulletin on "Street Trees." Trees on well-shaded streets not only contribute enjoyment but health by transpiring moisture and producing a restful effect on eyes and nerves.

Good shade adds to the value of adjoining properties. In fact, even in pictures, a house with trees and shrubbery will attract a buyer when the same structure without them would be disregarded.

Mixed plantings of different kinds of trees are not as pleasing and effective as the use of a single species for considerable distances. On the other hand monotony will result if the same species is used for an entire town or section. The varieties of trees suitable for city planting are not many, so all native to the section may be used, usually assigning one variety for a long stretch of street. Street trees are often planted too close together for the mature tree to thrive, a common practice being to plant them 35 feet apart although 50 or 60 feet would be ultimately a better distance.

A street tree must have healthy foliage that withstands dust and smoke, a root system adapted to unusual soil conditions, restricted feeding area and root pruning where street improvements are made. In the smoky heart of a city the allanthus or tree of heaven will probably thrive when nearly all other kinds fail. So also may the sycamore and plane. These are suitable for nearly all sections of this country. The maple is not as suitable a tree for street planting as many suppose because it is not sufficiently rugged except under suburban conditions.

The top of a street tree should be in proportion to the width of the street on which it stands, and should be of open growth without being too spreading. Narrow streets should be planted with columnar trees like the Lombardy poplar, or sometimes with small trees; broad streets with spreading trees like oaks or elms. The oak is designated as best for nearly every section of the country because of its hardiness and beauty.

Testing Biological Products in England

THE U. S. Public Health Service Reports that the Minister of Health of Great Britain has recently appointed a committee to consider and advise upon legislative and administrative measures to be taken for the effective control of the quality and authenticity of such therapeutic substances offered for sale to the public as cannot be tested adequately by direct chemical means. These include biological products, such as serums and vaccines, and mineral and vegetable bodies, such as salvarsan and digitalis, to which ordinary chemical tests are not applicable. In the United States the production and sale of viruses, serums, toxins, and analogous products are under effective Federal supervision so far as interstate commerce is concerned.

The Racing Airplane of the Future

(Reprint of a Study of Probable Future Developments, Originally Published in the Scientific American of Oct. 22, 1910)

By J. Bernard Walker

THIS article, originally published during the great airplane meet at Belmont Park in 1910, was an attempt to forecast the lines along which the development of the airplane would proceed. It was an engineer's loose study of a problem, to which the engineering profession was about to apply itself with results of which we were to see the culmination on the battlefields of France and in the memorable flights across the Atlantic. The present-day interest of this article will be found in its fruitful anticipation of subsequent developments, as seen in the oval, streamlined nascelle and the sheltered position of the pilot; the substitution of interior metal wing beams for exterior ties and struts; the retractable chassis; the gyro control of the ailerons; and the use of alloy metal throughout, with corrugated metal covering for the wings. After a lapse of eight years, the Germans, in the summer of 1918, produced the Junker all-metal war monoplane, with internally braced wings, covered with corrugated metal. At the present time the retractable chassis, as suggested in 1910, is being made the subject of much experimental effort.—THE EDITOR.

A STUDY of the trend of development in airplane construction renders it possible to predict with some degree of certainty the leading characteristics of the airplane of the future, and especially of that type which will be built purely for racing purposes. The following is an attempted study along these lines. The writer has no wish to assume the rôle of prophet, and the accompanying drawings and description are based mainly upon a survey of the work which has been done during the present year of phenomenal development by the designer, the constructor, and the airman. The keynote of this development is to be found in the fact that the speed of the airplane in straight-away flight has risen during the past year from fifty-five to seventy-five miles per hour and that the "blue ribbon" of the air (if we may borrow a nautical phrase) has passed from the biplane to the monoplane, the type which, at the present writing, is so far in the lead as to speed, lightness and stability, that it stands in a class by itself.

The racer of the future, then, will be a monoplane; and in narrowing down to this type, man is but treading in the footsteps of Nature, the master builder, who, working through a process of evolution that has stretched out over millions of years, has produced, in that wonderful bird, the albatross, the perfect flying machine. The future high-speed flyer, then, will possess the same tapering, rounded body and the wide-spread wings of narrow width which characterize the swiftest of the birds. Langley, in his classic researches, showed that it was the leading portion of a plane which was the most efficient, and this for the reason that it was continually moving on to fresh bodies of undisturbed air. He showed that as the after portion of the plane had to do its work upon air which had already received from the forward portion a downward velocity, this air was unable to provide the effective reaction which was exerted by air absolutely inert. Hence it follows that a plane 5 feet in width by 10 feet in length would be rendered more efficient if it were divided longitudinally, and the same area were presented in a plane 2½ feet wide and 20 feet in length. The wings of the racer will be long and narrow; and when they come to be built of metal instead of the present wood and fabric, it will be possible to give them those sweeping, rounded forms which prevent eddy-making, and also, from a constructional point of view, add not a little to the strength. The body will be of a generally circular or oval section; and to allow of a long and gradual taper, for ease in traversing the air, the body will have considerable length. The greater length also will add greatly to the fore-and-aft stability in flight.

The present wood-canvas-and-wire construction will have to go. It is makeshift work at the best, and was adopted because, in the early days of experiment, it offered a cheap and light combination of material, and one which, in the event of the inevitable breakages, incidental to experimental work, could be cheaply and quickly repaired. Its place will be taken by some one of the many remarkable alloys of steel which are now available—metals of enormous strength and toughness in proportion to their weight. The use of these, coupled with careful designing by the skilled engineer, will make it possible to produce an airplane of much greater strength, that will weigh no more than the present machine, and will present far less resistance.

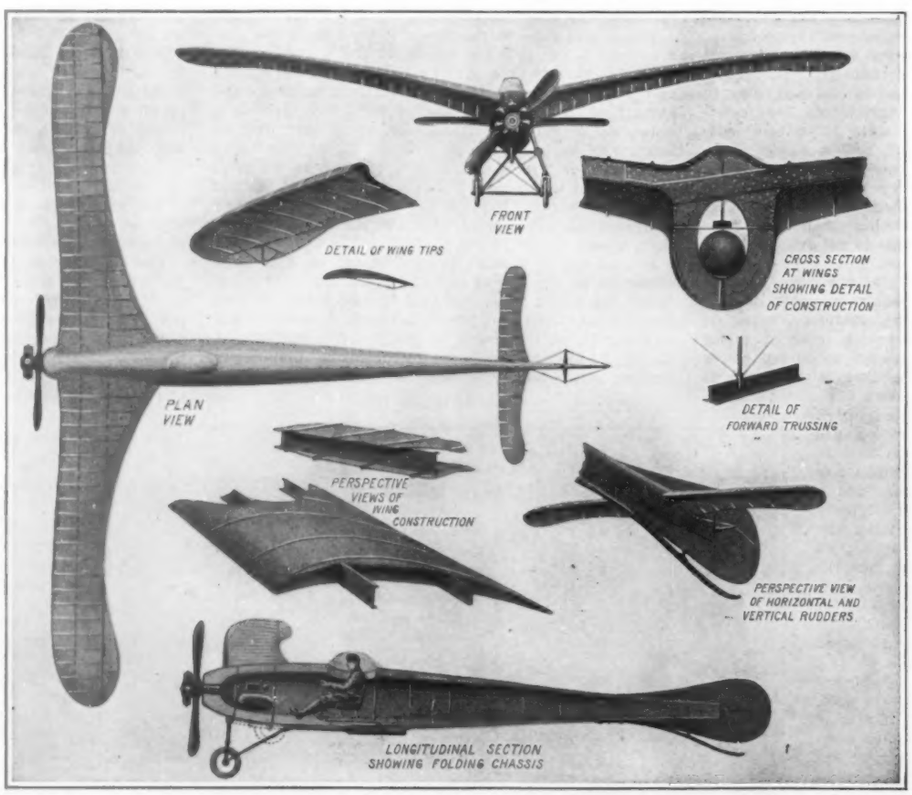
The principal resistances encountered by an airplane when in flight are those due to the lift and the head surface. The resistance due to the lift is fairly constant; for as the speed increases the angle of incidence decreases, and there is always an adjustment between the two which provides sufficient vertical reaction at all times to lift the weight of 500 to 1,000 pounds, as the case may be. The head resistance, however, increases approximately as the square of the speed; and if it is 100 pounds, say, at 40 miles per hour, it will rise to 400 pounds at 80 miles per hour. Hence the great importance, in a racing machine, of reducing the head surface to the least possible limit consistent with structural requirements.

It is the consideration of head resistance which has doomed the biplane as a purely racing type. When Octave Chanute built the first biplane glider, with its light, but very rigid Pratt trussing of vertical wooden struts and diagonal wire ties, he produced an excellent piece of engineering construction, which has proved to be ideally adapted to the early experimental stage which is now drawing to its close; but for high-speed results, because of the large amount of head surface presented, the Pratt truss was doomed to ultimate extinction. Unquestionably, the higher speeds which have been attained by the monoplane are due largely to the fact that its trussing is simpler, and the head surface, particularly of the wire stays, is relatively much less.

Now a word as to the resistance offered by a mass of tightly-strung wires. Professor Langley showed in his whirling-table experiments that the resistance of a wire is much greater than that which would be due to its projected area. As the speed increased, the resistance would rise rather quickly until, at a certain critical point, at which the wire would sing with a peculiar note, there was a sudden and very large jump in the resistance. This is explained by the fact that the rate of vibration of the wire under the rush of air is so great that it practically presents a solid surface, whose width is equal to the amplitude of vibration. Hence a tightly-strung wire presents a resistance to the air which is seemingly out of all proportion to its actual surface.

It follows, then, that even the simple king-pin trussing of the Blériot and Antoinette types must go if we are to achieve the high speeds which are predicted for the future racing machine. Now this will be possible only if some high-grade sheet metal is substituted for the canvas of the wing surface, and the necessary transverse bending strength is secured by means of plate-steel members enclosed within the wing surfaces and strongly riveted to the structure of the main body of the machine.

The form of wing shown in our drawings will afford a sufficiently strong construction in metal. The wings should widen considerably as they approach the body; for this would provide increasing space between the upper and under surfaces, and allow the depth of the channels to be increased proportionately to the bending stresses. These channels would be carried into the main body and riveted to transverse diaphragms, which should be so cut that the metal of the diaphragm would extend unbroken for some distance into the wings. We are convinced that by careful designing, the selection of the highest grades of steel, and by first-class workmanship, it will be possible to provide wings of ample strength without exceeding the limit of weight imposed by airplane requirements. Buckling in the fore and aft direction will be provided against by rolling the metal of the wing surfaces with shallow corrugations, as shown in the drawings. The main body of the airplane

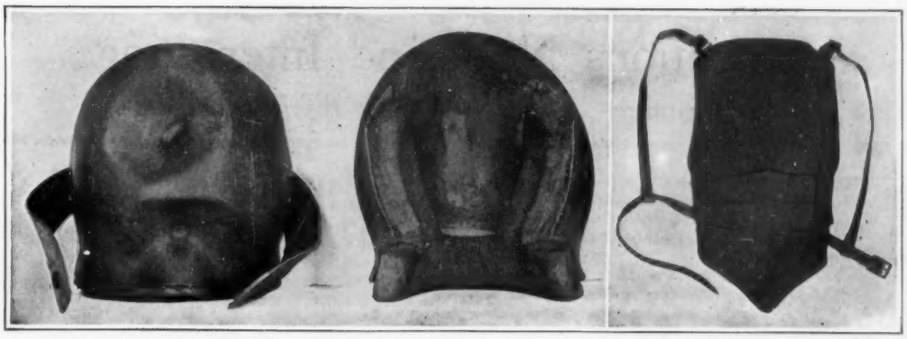

FRONT VIEW
DETAIL OF WING TIPS
CROSS SECTION AT WINGS SHOWING DETAIL OF CONSTRUCTION
PLAN VIEW
DETAIL OF FORWARD TRUSSING
PERSPECTIVE VIEWS OF WING CONSTRUCTION
PERSPECTIVE VIEW OF HORIZONTAL AND VERTICAL RUDDERS
LONGITUDINAL SECTION SHOWING FOLDING CHASSIS

This sketch, showing the probable development of future airplane designs and construction, was originally published in the "Scientific American" of October 22, 1910

(*Continued on page 168*)

Helmets and Body Armor in Modern Warfare

AMONG the many instances of a return to long-abandoned practice which were seen in the great war, was the universal adoption of the steel helmet and the tentative use of body armor. A work remarkable for its wealth of information has recently been written by Bashford Dean, Ph.D., Curator of Armor, Metropolitan Museum of Art, Major of Ordnance, in charge of Armor Unit, during the war. This book of 325 pages describes the various forms of armor designed and used for the American forces, and also discusses most entertainingly the helmets, body armor, et cetera, used by the principal nations engaged in the war. The work is most elaborately illustrated with line drawings and half-tones, and forms necessarily a most comprehensive, up-to-date work on this subject.



Experimental chin and face guard, front and rear views. Cushioned with sponge rubber

American laminated back plate of manganese steel. Stops 1000 f.s. bullet

In the years preceding the war, those of us who passed through the fine hall containing the Riggs Collection of armor at the Metropolitan Museum, regarded it as having an interest purely historical and artistic. Today we look upon those ancient and mediaeval forms with a new appreciation of their value. That armor could have been introduced during the late war and made effective, without loading down the soldier with an impossible burden, is due to the remarkable strides which have been made in the production of high-grade alloy steels of great resisting power in proportion to their weight. The bronze and other armor of the mediaeval times would not be effectual in stopping modern high-velocity bullets and shrapnel, but the manganese and other steels employed give to the modern soldier an immunity comparable to that enjoyed by the mediaeval armored knight against battle axe, sword and the swift-flying arrows of the Saxon bowmen.

We have selected a few illustrations from this volume which are characteristic of the several hundreds with which it is richly illustrated. Among these is a type of face guard, a device to accompany a helmet of the British type. This is an adaptation of the face guard of the fifteenth century. It encloses the face, rests on the chest and is held in position, not too tightly, by leather bands provided with snap fasteners. To absorb the shock of impact, the guard is provided with a lining of sponge rubber. This guard stopped the automatic revolver bullet at ten feet. A number were sent to the training camps and tried out and although the soldiers complained that it was a bit "stuffy," there can be no doubt of its value. That it is practical seems clear from the fact that the same form was in general use in Europe from 1450 to 1550.

We also reproduce the photograph of an experimental American body armor which consists of five pieces. The upper and larger portion covers the chest and stomach; to this are riveted two sections which protect the abdomen; below this, attached by leather straps and buckles, are two pieces of armor which afford protection to the upper part of the thighs. This armor is made of Baker's nickel-manganese alloy, and in the tests, at a distance of 200 yards, it served to stop a rifle ball fired with an initial velocity of 2,800 feet per second. With this may be compared the British body armor brought out in 1917-18. In its effort to furnish an improved type of body defense, the British Government, through its Munitions Inventions Board, manufactured the corselet which we illustrate. It weighs nine and one-half pounds and is formed of three elements—a breast plate, a back plate, and what is called a "sporran" piece. These are covered with khaki drill and are slightly padded. It will resist the ball of the automatic pistol, and also shrapnel and grenade. It will stop a bullet traveling at a rate of 1,280 feet per second. The plates are made of twelve per cent Hadfield's manganese steel of eighteen gage. This model was issued in pretty large quantities.

Between these samples of American and British armor we show an American model helmet which, if the war had continued, would probably have super-

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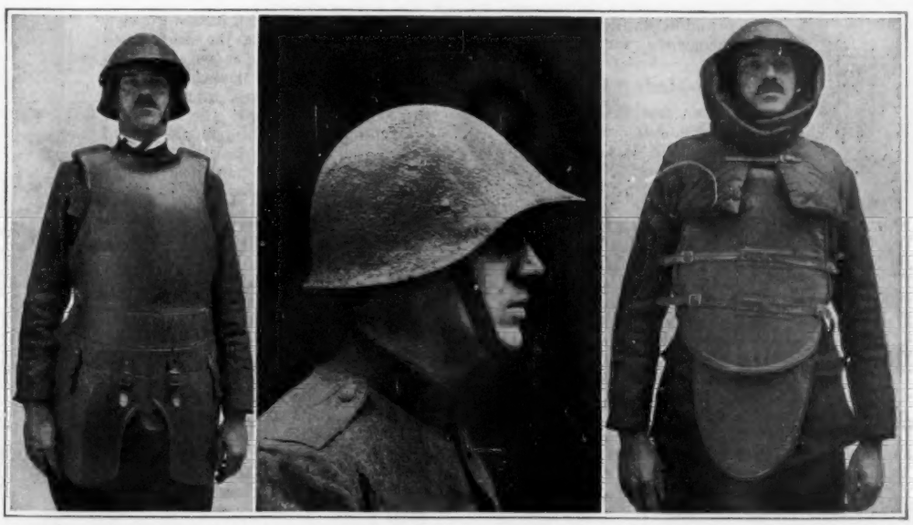


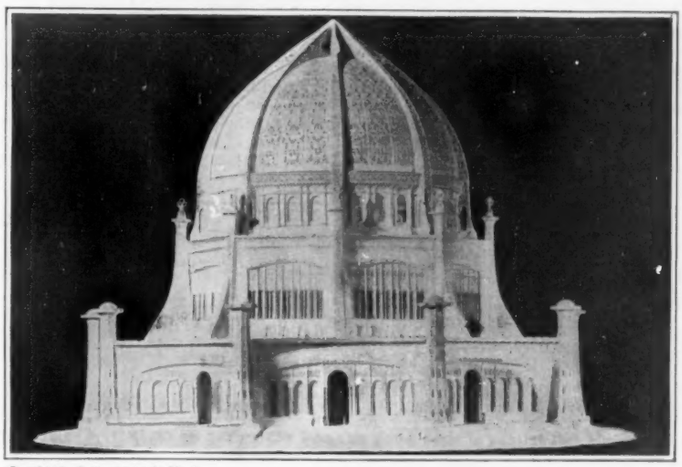
Experimental American body armor. Stops rifle bullet at 200 yards

American helmet No. 2. Improvement on British type. Protects back and side of head

British body armor of 1917-18. Stops rifle bullet at 1280 feet per second velocity

Exotic Temples for Our Two Greatest Cities

A NEW religion, a new style of architecture—a style derived from astronomy, these are all things to animate the jaded mind after the war languor. A new religion coming from the East is a matter of course and hardly causes a ripple of either interest or enthusiasm; but the idea of a combination of religions or rather unity of nine which is unity in "spirit and in truth," is most extraordinary. Let us for the sake of argument have a religious "League of Nations" with the capitol in Persia, the chief promoter living in Palestine and the two great temples in Chicago and New York! This is an astounding proposition in itself, without considering for the moment the architectural setting for the two temples. We might as well tell the name of this new cult now as later—it is the "Bahai Movement," which, according to its devotees, is to weld together all the religions of the world in a common religious unity. The idea is common enough, and has been shaking the universe since the "Oxford" or "Tractarian" movement in the middle of the last century. It is the desire to gain unity without undue concession which animates all real inquirers.



Copyright by L. Bourgeois, Architect

An exotic Bahai Temple for the metropolis of the East and of the West

The Bahai movement assumes that there are nine of the great religions and that in a temple there should be nine sides with doors over which are inscribed a welcome in the language of the race to which the portal belongs. Within we are not to see nine pulpits with nine kinds of priests, rabbis, or exhorters in nine kinds of vestments or without them. The paraphernalia of religion is left out in the daylight, and in the dim religious light we have worship, music, and, above all, beauty. The effect produced on the visitor would be something akin to that wonderful Masonic Scottish Rite Hall in Washington where even the most hardened atheist and sinner would be softened by the combination of music and dim religious atmosphere. There is no other creed than the brotherhood of man and no other organization than a body of temple trustees who will govern the fabric.

The plans of the architect, Louis Bourgeois, differ somewhat in his earlier and later models, but our illustration suggests a compromise design which for real beauty is almost without a peer.

The architect has wrought into his decorations such symbols as the cross, the swastika, the five, six and nine-pointed stars. The use of vines, leaves and figures has been eschewed and purely mathematical lines have been substituted. The architect has derived his inspiration from the study of astronomy, for the overlapping curves which the planets trace in their different planes are very beautiful as they circle around in the heavens. The dome is the essential feature and somewhat suggests the so-called "Dome of the Rock" in Jerusalem, wrongly called the "Mosque of Omar." The external ribs are most pronounced, meeting in a Gothic point, suggesting hands clasped in prayer above the head.

The first story is Roman in its window arches, while the second is more Greek, and the next story suggests Chinese influence. In fact, it is a remarkable architectural blending. The building will cost several millions, but the result will be worth it.—By *A. A. Hopkins.*

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

Copyright, Kadel & Herbert

Tearing a piece of wrapping paper from a roll placed below the counter

Keeping the Wrapping Paper Out of the Way

ONE of the latest aids to speeding up the wrapping of packages in stores and shops is shown in the accompanying illustration. It consists of a brass-lined slot in the counter top, through which protrudes the end of a roll of wrapping paper kept below the counter. When a piece of paper is wanted, the end is pulled until the desired length is attained, and by pulling the paper at an angle it is cleanly torn by the brass sides of the slot as shown. Not only does this arrangement save considerable room on the counter, but it is said to be considerably more convenient than the usual paper holder and cutter.

Magnifying the Meter Scale for Better Readings

CENTRAL electrical stations and laboratories of public utility commissions, where rapidity and accuracy in testing of electrical apparatus are desirable, will find useful an instrument reading camera recently developed by the U. S. Bureau of Standards. The time element in testing instruments is appreciably reduced and only faults inherent in the electrical equipment are detected as errors. Any possible discrepancy of reading at the time of the test is virtually eliminated.

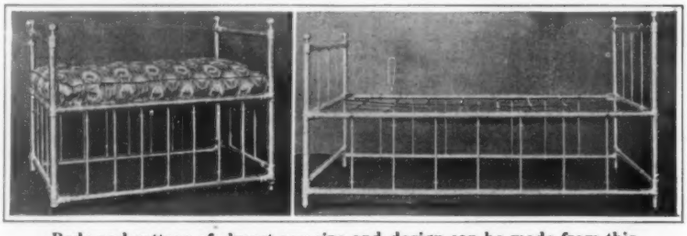
The scale of the instrument subjected to the test is brightly illuminated by a concentrated filament tungsten lamp and a system of mirrors and condensing lenses. Another lens and a right angle prism are mediums for flashing upon a ground-glass screen an image of the scale and pointer, magnified by five diameters. The enlargement of the object greatly reduces the possibility of error in reading the electrical instrument and when properly adjusted eliminates parallax error.

This instrument shows up the meter reading in greatly magnified form for convenient reference

The reading camera is easily adapted to making observations from either vertical or horizontal scales. By the use of this device the results are more satisfactory as both eyes can be kept open and the head held in any convenient position. The reading camera is especially valuable in laboratories such as those maintained by central stations and public utility commissions where the position of a pointer over a scale is to be read rapidly and with considerable accuracy.

Furniture That Comes in Bundles

SOME ingenious Frenchman has invented a system of knock-down interchangeable unit furniture that is certainly unique and perhaps practical as well. The basis of this system is to be found in a collection of rods, tees, elbows and other fittings, which can be assembled in many different ways to form all sorts of furniture. The rods and fittings are bought in a store, and the purchaser then proceeds to make any desired bed or other piece of furniture within the limitations of the system. For instance, sufficient rods and fittings can be bought to make a small crib for the infant, and later, when the infant has grown to childhood, additional rods and fittings can be bought in order to enlarge the crib or even change it into a single bed or couch. The system also lends itself to making tables, settees, wardrobes and other furniture, although its prime purpose is for beds.



Beds and settees of almost any size and design can be made from this ingenious system of rods and fittings

Machine-Made "Real" Lace

AN invention has just been patented for the manufacture of imitation "real" laces, by H. F. Soar, of Nottingham, which it is claimed will revolutionize the present methods of making imitation "real" laces. The inventor states that by the means of his invention, which is an attachment to an ordinary Levers lace machine, he can produce the lace the entire width of the machine, either in breadths from one inch upward or the full width of the machine for allover nets. Thus, a machine 100 inches wide could be made to produce 100 breadths of one inch, or 50 of two inch, and so on. Two sets of jacquards are used, one operating the warp threads and the other the bobbin threads.

The inventor considers that these machines can be worked by female labor, and that the laces could be produced cheaply. Hitherto imitation "real" laces have been made on the small, rapid, circular machine which weaves but two breadths.

A Bicycle That Rides on Rails

RAILROAD inspection and repair work on a very modest scale are somewhat simplified by the introduction of a French invention which permits an ordinary bicycle to be ridden over railroad tracks in the manner shown in the accompanying illustration. The device consists of an attachment which serves to hold the bicycle squarely on one rail. The result is that the bicycle can be driven at a high rate of speed over the perfectly smooth surface formed by the rail. When the rider wishes to change from the railroad to an ordinary road, he merely detaches the simple framework, folds it up, and proceeds in the conventional manner by carrying the light framework along.

Putting the Stove Chimney to Useful Work

THE fuel scarcity that prevails throughout most of Europe has aroused inventors to put forth their best efforts on the problem of securing new fuels on the one hand, and getting more heat out of old fuels on the other. A short while ago we presented in these columns an English invention for getting heat out of compressed sawdust. This time we present a French invention for getting more heat out of the conventional stove by changing the arrangement of the chimney.

The French call this latest invention the "spirale radiatrice," or heat-radiating spiral, so to speak. It consists of a stove chimney made in the form of a spiral and connected at either end with the usual chimney which passes through it. In actual operation the draft from the stove can be made to pass more or less through the spiral passage by means of suitable draft valves, in accordance with the requirements of the fire. The more draft passes through the spiral passageway the more heat is obtained from what would otherwise be wasted heat passing up through the chimney.

Electrical Sterilization of Milk

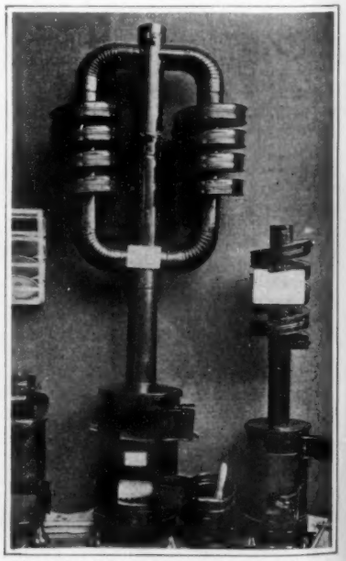
A SPECIAL report has just been issued by the British Medical Research Committee, dealing with the destruction of bacteria in milk by electricity. In the introduction it is pointed out that the earliest description of an electrical method having this purpose in view was published by the Liverpool (England) Corporation in 1915, the investigator being Prof. J. Martin Beattie, of the University of Liverpool. Subsequently independent trials of the method were undertaken at Birmingham, and the opinion of the committee is that these latter experiments, while supporting the practical results obtained at Liverpool, did not entirely prove whether the electrical current in the method adopted had a directly bactericidal action or acted as a thermal agent. Sir Oliver Lodge inclined to the latter view.

This simple framework enables the railroad worker to ride a bicycle on the railroad tracks

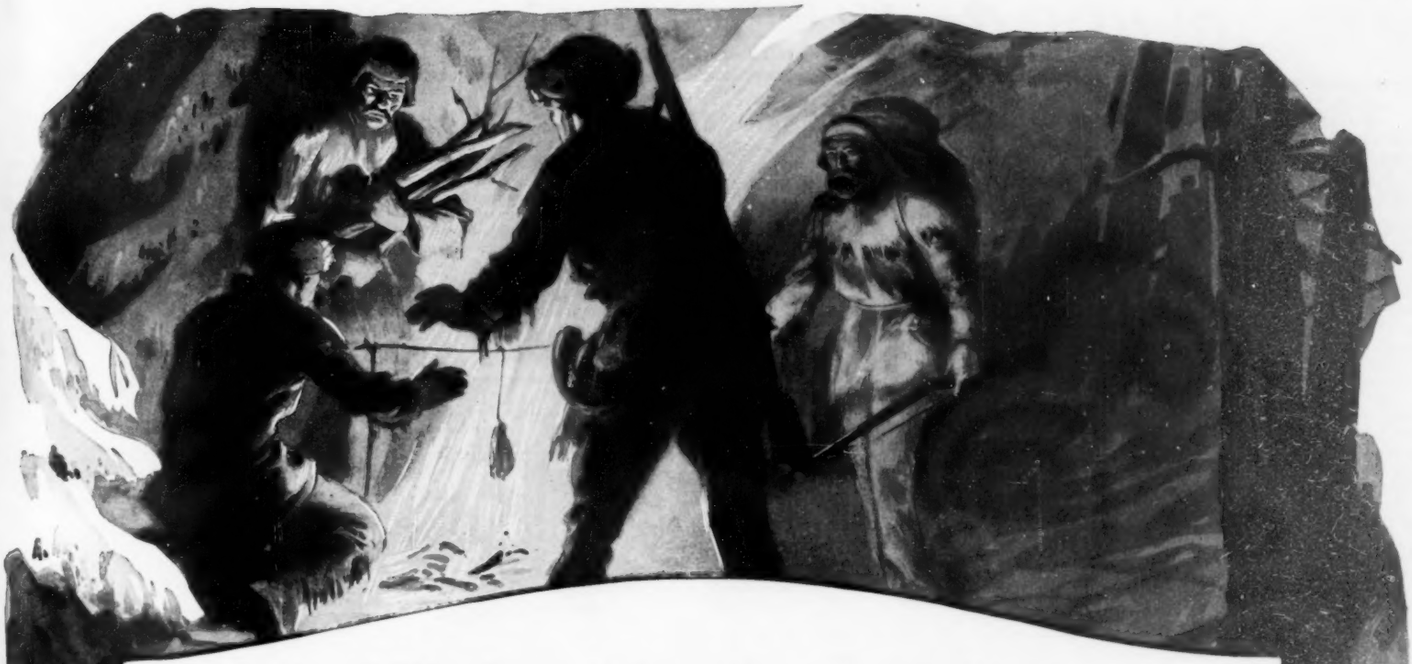
The report itself has been prepared by Professors Beattie and Lewis, both of Liverpool University, and enumerates the results of 15 experiments under varying conditions, with different degrees of current and with several qualities of milk, as well as showing two types of apparatus used. The final conclusions arrived at by the investigators are:

Milk can be rendered free from *B. coli* and *B. tuberculosis* by the new electrical method described without raising the temperature higher than 63° or 64°C. This temperature effect is very short in duration and in itself is not the principal factor in the destruction of the bacteria. Though the milk is not sterilized in the strict sense of the word, yet the percentage reduction of the bacteria taken over a period of a fortnight is 99.93. The keeping power of the milk is considerably increased.

The taste of the milk is not altered, and so far as careful chemical examination can determine the properties of the milk are not in any way impaired. The milk can accurately be described as "raw milk" free from bacteria.



More heat from the stove is the object of these spiral draft chimneys



Coal and Wood say, "Come to me for heat" Electricity says, "My heat is at your finger tips"

CAN you imagine a fire in Chicago and benefiting from its heat in New York? Yet that is what virtually happens in the case of electric heat. A current is generated, sent miles across country and converted into heat, wherever desired—instantly available, easily controlled and concentrated to the highest degree.

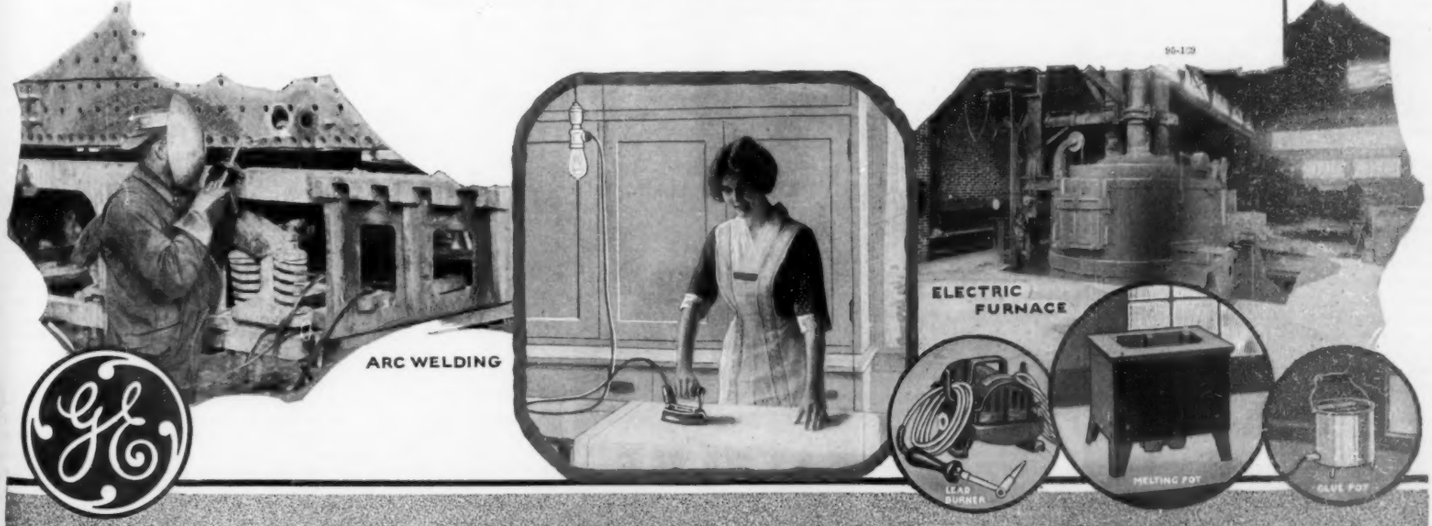
Domestic needs have produced the electric oven, cooker, broiler, toaster, flat iron, hair curler, percolator, glow heater and grill. These have eliminated drudgery, reduced fuel bills and fire risks, promote cleanliness and simplified housekeeping. In some states plentiful power from water sources and scarcity of fuel have made the heating of homes by electricity practical and economical.

In place of the grimy forge and the primitive bellows of yesterday, modern industry calls upon electricity to heat rivets, to alloy and temper metals, to weld and cut, to bake enamels and varnishes, and to perform speedily and more efficiently the thousand and one tasks that require heat. Electric furnaces, arc welders, glue pots, soldering irons, brazing machines—each one has the proper control to produce just the right amount of heat.

The broad utilization of electric heat has only begun. It has already called upon every resource of the General Electric Company: study, research, engineering and manufacturing.

While the problem of obtaining more power by connecting cities with far away water power and steam plants is being solved, the efficiency of the application of electric heat will also be studied so that electric heat may take its place with power and light as a universal benefit to mankind.

96-129



GENERAL ELECTRIC COMPANY

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Of Interest to Farmers

CULTIVATOR.—R. S. MATTINGLEY, Rockport, Ind. An important object of the invention is to provide a cultivator of the straddle-row type which may be readily and easily adapted to the cultivator of a great variety of crops and in which all of the subsidiary operations incidental to the use of the cultivator such as the adjustment of the cultivating or earth-working elements, the steering of the cultivator; the control of the draft, etc., may be efficiently carried out under the control of a single operator.

SHEAF DISTRIBUTER FOR THRESHERS.—R. B. MASON, 19 W. Patriot St., Somerset, Pa. The invention relates to distributing devices, more particularly to be used in connection with a thresher. An object is to provide a sheaf distributer for alining the sheaves and conveying them in an orderly manner to a thresher with which the distributer coöperates.

CONTAINER FOR SHEAF LOADERS.—R. B. MASON, 19 W. Patriot St., Somerset, Pa. One of the foremost objects of the invention is to provide a form of bottom for a sheaf container, which consists of a plurality of independently movable conveyers which can be separately actuated to shift the load into more advantageous positions. Another object is to provide a mechanically actuated gate coöperating with the movable bottom of the container, the gate being adjustable either high or low to regulate the quantity of sheaves discharged.

Of General Interest

SQUEEZER.—S. E. CREASEY, Sanford, Me. The invention relates to juice extractors commonly known as "lemon squeezers," which may of course be used for other fruit. An object is to provide a device which is provided with an opening in the upper end of its ribbed or corrugated conical body portion to accommodate the core of the fruit, and which will also operate to cut the fibers connected to the core and thus expose the meat to the squeezing action against the surface of the core to thoroughly extract the juice.

BROOM.—T. A. VOSS, Phoenicia, N. Y. More particularly the invention relates to that class of brooms the sweeping or dusting portion of which is folded and retained in a binder by a retaining bar seamed in the ends of the binder. An object is to provide a device whereby old newspapers can be utilized for the sweeping element, by so constructing the broom head as to permit newspapers or other foldable sheet material to be quickly put in place to sweep and is readily removed for renewal.

HEEL FOR SHOES.—A. R. SCHAEFER, 140 W. 10th St., New York, N. Y. The invention relates more particularly to heels of the resilient type. The primary object is to provide a lift for heels which is readily detachable from the heel proper when the lift has become worn. A further object is to so construct the heel that it may be readily attached and detached so as to render unnecessary the services of a person skilled in the art of shoe manufacturing or repairing to carry out the operation.

PERFUME VIAL.—A. VERICEL, 315 W. 136th St., New York, N. Y. The invention relates to a method of disseminating perfume and the provision of a perfume vial. The desired evaporation of certain perfume oils may be obtained if minute particles thereof are exposed to contact with the air for evaporation. The object is to dispense the perfume without the use of alcohol; this is accomplished by providing capillary means through which the perfume oil passes to contact with the air.

FLOATING DEVICE.—G. JORDAHAN, Palm Beach, Fla. An object of the invention is to provide a device in the form of a life preserver wherein a proper supporting member is provided when wanted and a light package when not wanted. Another object is to provide a device which may be tied around the body or fastened in a number of ways without effecting its usefulness, and which may be folded into a minimum sized package when not in use.

SELF-OPENING CONTAINER.—C. GUELITEY, address C. S. Humphrey, c/o Manhattan Can Co., Bush Terminal Bldg., No. 10, Brooklyn, N. Y. The invention relates more particularly to a container which is air-tight and adapted to be self-opening. Among the objects is to provide a container having a cover and a main body portion which is simple in construction, economical to manufacture and which may be opened without requiring the use of instruments or other means for separating except merely dropping the box suddenly. The box is particularly adapted to receive paste or other semi-liquid material.

WOODEN SHOE OR SANDAL.—P. DEMARMELS and A. WINKLER, 161 Avenue B, New York, N. Y. The object of this invention is to provide a wooden shoe or sandal having a wooden sole made in sections hinged together to provide a desired flexibility and thus to insure ease and comfort in walking. Another object is to conceal the hinges connecting the sole sections to prevent the corroding influences such as moisture, water, acids and the like from reaching and injuring the hinges.

RIMMED EYEGLASSES AND SPECTACLES.—S. GOLDFADEN, 609 W. 114th St., New York, N. Y. The invention relates to eyeglasses having rims of shell, celluloid or other similar material. The object is to provide rimmed glasses and spectacles whereby an optician is enabled to quickly and conveniently fit any one of the many types of bridges or temples to the rims as desired by a customer, and to permit the optician to conveniently place the lenses in position in the rims without requiring heating thereof.

FALSE BOTTOM FOR GARBAGE RECEPTACLES.—C. J. JACOBSSON, c/o M. Rock, 315 5th Ave., New York, N. Y. The object of the invention is to provide a false bottom of paper or similar cheap material for garbage cans and similar receptacles used in households, restaurants and other establishments, and arranged to maintain the receptacle in a sanitary condition when emptying it of its contents, especially protecting the bottom of the receptacle against adherence of moisture, fats and like matter.

COVER REMOVER.—A. S. MORANGE, 129 King St., Northampton, Mass. This invention relates to cover removers and has reference more particularly to a cover remover provided with means adapted to first cut the label on a can and then lift the cover with a wedging action. Another object is to provide a cover remover especially adapted for removing the covers of cans without spilling the contents thereof or damaging the cover.

COFFEE URN.—A. M. SALAZAR, 108 W. 44th St., New York, N. Y. The primary object of the invention is to so arrange the process of making coffee that the ordinary coffee urns commonly used in restaurants and like places may be eliminated and the liquid coffee made direct from the water boiler generally employed in restaurant kitchens. A further object is to provide a device in which various quantities of coffee may be brewed at a single operation.

ROLL-FILM CARRIER.—O. C. HUMMEL, Box 86, R.F.D., No. 2, Nauvoo, Ill. An object of the invention is to provide a neat carrying case for containers of roll films in which a number of containers for film rolls may be carried and protected from the weather and in which means is provided for inserting containers having exposed films at the bottom of the carrier and for removing containers having unexposed films at the top.

SHOE STRETCHER.—H. WATERS, Box 182, Bisbee, Ariz. The object of this invention is to provide a device by means of which the shoe may be stretched in many directions either longitudinally or laterally at different points or in a vertical direction; a stretcher plate is provided which may be set in place at the point where it is desired to stretch the shoe.

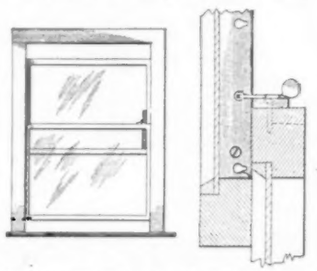
SELF-RAISING LID FOR ICE-CREAM CABINETS.—C. R. RAGSDALE, c/o Liquid Carbonic Co., 539 Magazine St., New Orleans, La. The general object of this invention is to provide a lid of the indicated character provided with means whereby to automatically throw the lid to the raised position whenever the latch means releases the lid. More specifically the object is to provide an embodiment of a simple and durable form as well as convenient to install.

OIL CAN.—J. H. HALL and W. B. HAMILTON, Rupert, Ida. This invention has for its object to provide an oil can having means for permitting the oil to be forced from the can in spurts or in a steady stream by grasping the can between the thumb and the first two fingers and making pressure with the thumb toward the fingers with the can so held.

ROOFING.—R. W. BLANTON, Ironton, Ohio. The invention relates to sheet metal roofing. The object is to provide lock-joint metal roofing sheets of such formation that not only can successive sheets of one course be interlocked, but successive courses can be lapped over each other, the lock-joints of one course coming substantially in the middle of the sheets of the course below, thereby staggering the lock-joints and forming what is known in the art as a "break joint" construction. A further object is to provide lock joints which will not become separated by expansion and contraction under the influence of heat and cold.

Hardware and Tools

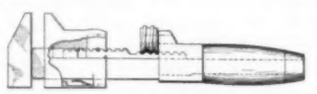
WINDOW LOCK.—R. BELLINGER, 226 E. Main St., Chicopee Falls, Mass. The object of the invention is to provide a window locking device which will lock a window in closed position or in any of several open positions so as to secure ventilation at the top or bottom of the window or both, the device when in



A VERTICAL SECTION OF THE DEVICE AND CONVENTIONAL FORM OF WINDOW WITH DEVICE APPLIED

locking position preventing rattling of the window. The lower sash is provided on its upper edge with a locking member which co-acts with a keeper secured to the upper sash for locking both the sashes against movement relatively.

WRENCH.—H. B. WINTER, County National Bank Bldg., Punxsutawney, Pa. This invention has for its object to provide a wrench wherein a fixed jaw is provided with a movable jaw adjustable toward and from the fixed

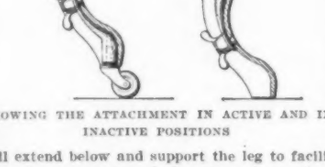


A SIDE VIEW WITH PARTS BROKEN AWAY

jaw with a coarse and a fine adjustment, the said adjustments being independent of each other. In order to attain the coarse adjustment the movable jaw is tilted and moved toward the fixed jaw to engage the object; when so engaged the fine adjustment may be attained by means of a worm.

Heating and Lighting

CASTER ATTACHMENT FOR STOVE LEGS.—J. O. SABOM, 616 Tower Ave., Superior, Wis. A purpose of the invention is to provide an attachment for supporting a caster on a stove leg in such manner that the caster



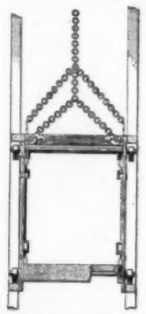
SHOWING THE ATTACHMENT IN ACTIVE AND IN INACTIVE POSITIONS

will extend below and support the leg to facilitate the movement of the stove from place to place, but the caster is capable of being moved to an inactive position after the stove has been moved and will function as before to prevent accidental movement of the stove.

HEATER FOR WASHING MACHINES.—H. S. CARSON, 139 Prospect St., Stamford, Conn. The invention relates to a heater which is more particularly applicable to washing machines, and aims to provide a device wherein the soapy water usually wasted may be heated again and reused; means are associated with the heater for maintaining the fluid at a proper temperature. A further object is to associate the heater with the washing machine in such manner that the fluid may be drained from the heater into the washing machine, or vice versa.

Machines and Mechanical Devices

SAFETY DEVICE FOR ELEVATORS.—L. COURTY, Windsor, Mo. An object of the invention is to provide a simple and durable safety device for elevators in which the elevator will



FRONT ELEVATION OF ELEVATOR EQUIPPED WITH THE DEVICE

be securely and positively locked to the guide rails when the supporting cable does not serve to support the elevator or breaks, or whenever the elevator is in danger of falling irrespective of its position in the elevator shaft.

HEDDLE.—H. RUEGG, JR., 12 Kingswood, Wechawken, N. J. The inventor has been granted two patents relating to heddles for looms. The objects are to provide a heddle arranged to permit the weaver to readily engage a warp thread with the eye of the heddle without the use of a hook or similar tool. Another object is to prevent the warp thread from passing accidently out of the eye on raising and lowering of the heddle. A still further object is to permit of making the heddle of one single strip of metal or other material.

CUTTING AND ROUNDING-OFF MACHINE FOR TEETH FOR CLOCKS.—F. L. W. BUCKMANN, Amsterdam, Holland, Netherlands. This invention relates to a machine for cutting and rounding off the teeth on spur and bevel toothed wheels and pinions for the clock work and instrument makers' trade; an object is to make the machine very simple and compact in order that it can be easily handled in the clockwork makers' and instrument makers' trade.

EQUIPMENT FOR MOVING PICTURE MACHINES.—R. N. VYNE, c/o Vyne Bros. Electric Co., Reif Bldg., Prescott, Ariz. The object of the invention is to provide equipments for moving picture machines whereby a shutter is interposed between the distant screen and the source of light of the corresponding moving picture projecting machine used at the time with a view to prevent the undesirable red afterglow appearing on the distant screen on stopping the projecting machine. Another object is to keep one shutter of the non-active machine closed while the other shutter for the machine in use is open.

LIQUID MEASURING DEVICE.—J. D. MEREDITH, 60412 8th St., Wichita Falls, Tex. More particularly the invention relates to liquid measuring devices for dispensing gasoline, oil and the like. An object is to provide a device which will actually indicate both to the buyer and seller the amount of liquid dispensed. A further object is to provide means which will permit the buyer to see the condition of the gasoline before it is delivered from the machine.

FUR SCREEN.—T. TRAVIS, c/o Knox Hat Co., Grand Ave., Brooklyn, N. Y. This invention relates to screens for receiving fur from felt pad forming machinery, and has for an object to provide a construction which will continuously operate and thereby obviate the necessity of shutting down at any time. A still further object is to provide a screen whereby air may keep the screen clean and at the same time escape as the fur matter passes a receiving container.

PUMP.—H. JACKSON, 1633 E. 13th St., Brooklyn, N. Y. The invention relates to a pump which is peculiarly adaptable to the

(Continued on page 164)

Organization—Equipment—Knowing-how Produces the new Leland-built Motor Car

In this day of big things, what more magic words than these: 'Organization,' 'Equipment,' 'Knowing-how?'

Without them is nothing great accomplished.

With them, nothing seems impossible.

Many are the stories of vast achievement in the world mechanical; among them is a story not widely known, yet a story for whose parallel you would seek far to find.

In order to understand the possibility of that achievement, let us hark back some thirty to forty years.

Then, Henry M. Leland was a conspicuous figure, in New England's higher craftsmanship.

Some years before, he had left his boyhood home on the farm in Vermont, and gone to Worcester, Mass., where he engaged as an apprentice. He became a workman at the bench, but not for long, because he soon compelled recognition as an artisan of an uncommon kind. He showed an ability to do things— to do them differently, and to do them better than they had been done before.

He became a machinery salesman, and an unusual one, because he was more than a salesman.

He knew, too, how to install and to teach the operating of the machines he sold.

Manufacturers sought his counsel. They engaged him to re-organize their equipment and their men.

He knew how to increase production, not by oppressive, but by progressive methods. He did two more things, which to those who do not know him and his methods, may seem anomalous or impossible—yet he did them.

Besides increasing volume, he actually reduced production costs, and at the same time bettered infinitely the quality of the things produced.

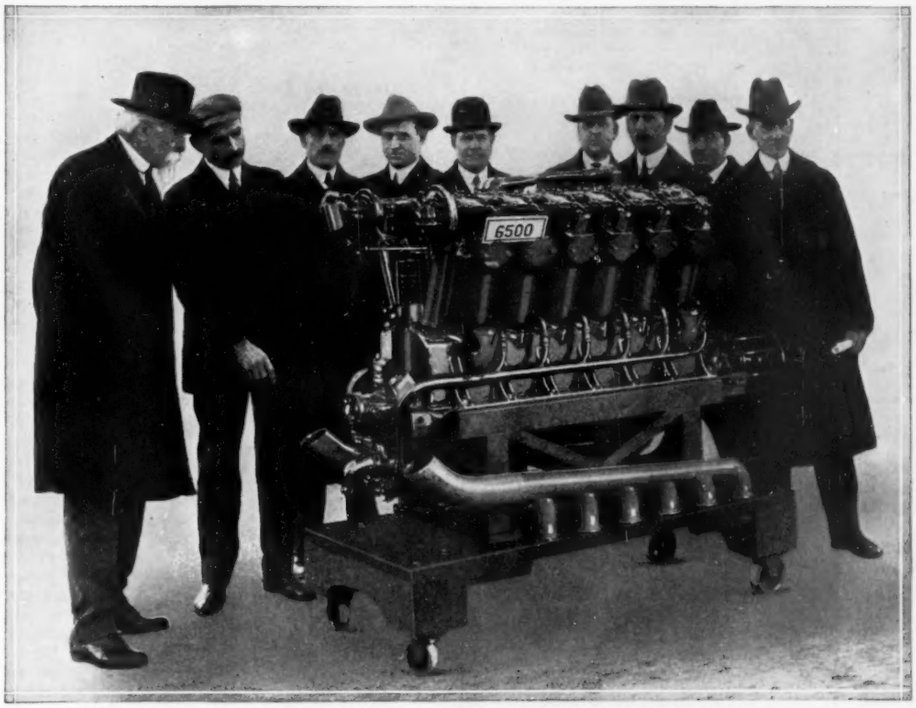
He had a knack and a penchant for doing things while others were saying they could not be done. His was supreme delight to bring order out of chaos.

Many are the great establishments today which owe the foundation of their prestige and their success largely to the organizing, producing and quality-building genius of Henry M. Leland.

He is credited with a multitude of 'crowning achievements,' because he has made it a life principle always to do things better than they had been done before.

His generalship in organization is strikingly exemplified in that of the Lincoln Motor Co., although he maintains that Wilfred C. Leland who has been his mainstay and close associate for many years, assumed a large share of the responsibilities; and to its success he also attributes the loyal, skillful and effective co-operation of his thousands of other associates.

In the year 1890 the Lelands came from New England to Detroit, where for a number of years they engaged in the manufacture of the finer kinds of machinery and precision tools. They were among the pioneers in the making of gasoline marine and automobile engines; and after eighteen years, many of those engines are still in service—a tribute to the Leland ways of doing.



Henry M. Leland, Wilfred C. Leeland and some of their Chief Associates, viewing the 6,500th Lincoln Liberty Aircraft Motor

Of these nine men, seven have been in continual relation for 12 years; five for 21 years and three for 27 years

A Duplicate of this Motor is now in the Smithsonian Institution at Washington, D. C., where it will stand for all Time, a Monument to and an Example of the world's finer Craftsmanship

Shortly after our country became involved in the world conflict, the vital need for aircraft so forcibly impressed itself upon the Lelands that they severed their many years' affiliation with the motor car industry, in order that they might undertake the production of Liberty airplane motors for the allied fighting forces. This they did in July, 1917.

With absolutely nothing in the way of plant or equipment, they received the government's first award for the building of these motors—and faith in the men and their ability was the government's sole assurance.

Capital was interested, and much volunteered. The Lincoln Motor Co. was formed. Fifty-two acres of land were acquired. An adequate plant was erected and equipped in record time. A vast amount of machinery was designed, built and installed. Tools to the extent of 6,522 separate and distinct designs, aggregating 91,807 in number were made.

Thousands of America's most skilled craftsmen tendered their co-operation and their services. Many of the men, particularly the executives, were men whom the Lelands knew and who knew them, through many years' association; and they were anxious to enlist under their banner.

Never in their lives, say the Lelands, have they seen such a vast organization get into working harmony with so little delay and so little friction.

The efficiency of that organization can best be appreciated when it is realized that in seven months and three days after starting with nothing, they assembled their first motor. In ten months thereafter, and with 6,000 employees, the Lincoln Motor Co. was producing at the rate of 50 motors per day. In contrast with these Leland methods, the leading English manufacturer, with three years' aircraft experience and 10,000 employees, had required a week to produce the quantity of motors which the Lincoln organization had produced in a single day.

Within eleven months from the day production of completed motors began, the Lincoln Motor Co. had established the record of producing the largest number of motors in a day, the largest number in a month and the largest total produced by any manufacturer from the beginning; and those who know the story of Liberty motor building know the rivalry for that record.

The quality of Leland-built Lincoln Liberty motors has been attested by tributes and in ways which could not be misunderstood; and, too, the Lincoln Motor Co. was able to render assistance of immeasurable value to those less favorably schooled.

Assembling and harmonizing an organization expeditiously, for doing things in a big way and doing them right, is, like everything else—no matter how difficult it may seem—a plain, simple matter of 'knowing how.'

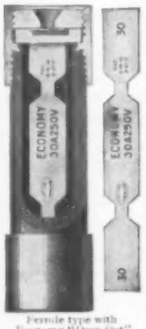
This is simplified when the executive and his chief assistants in things mechanical can go into the shops, and with their own hands perform practically every task and operation, from the ground work to the finished product.

Such is the skill and genius; such is the organization that is producing the new Leland-built car—the car destined to chart the future course of fine car making—the car destined to prove another 'crowning achievement'—the car destined once more to demonstrate Leland determination and Leland ability to surpass.

LINCOLN MOTOR COMPANY DETROIT, MICHIGAN

You Buy the Highest Type of Electrical Protection

in any circuit when you install Economy Renewable Fuses—made in both ferrule and knife blade types in all capacities.



Ferrule type with Economy "Drop-Out" Renewal link

Accurate rating, practical, safe fuse construction and a dependability which has been proved for years in thousands of industries, large and small, make Economy Fuses first choice where efficiency is the first consideration.

ECONOMY *renewable* FUSES

And You Cut Fuse Maintenance Cost 80%

compared with the maintenance cost of any "one time" fuse equipment.

Knife-blade type with Economy "Drop-Out" Renewal link

Only the "Drop Out" Renewal Link is destroyed when the fuse blows.

Both ferrule and knife-blade types are easily and quickly restored without expensive delay in service.

Economy was the first line using inexpensive bare renewal links for restoring blown fuses to their original efficiency to be APPROVED IN ALL CAPACITIES by the Underwriters' Laboratories.

Sold by all leading electrical jobbers and dealers

Economy Fuse & Mfg. Co.
Chicago, U. S. A.

Economy Fuses are also made in Canada at Montreal.

RECENTLY PATENTED INVENTIONS

(Continued from page 162)

pumping of fluids, such as oil, water and gasoline although the same may be used for any fluid. Among the objects is the provision of a single valve which will present two separate pistons, so that all parts such as springs, etc., may be eliminated, a tight seal formed within the pump, a bearing which will efficiently lubricate the moving parts and to so construct the pump that it is impossible for the most unskilled laborer to apply the same improperly.

FIREPROOF FILM REEL.—W. RICE, 88 Cumberland St., Brooklyn, N. Y. The invention aims to provide a film reel which shall be entirely fireproof so that no possibility of an explosion occurring in the operator's booth. A further object is the provision of a film reel in which a film may be transported and be guarded against any accident, the end of the film readily attached to the securing means, and the provision of a structure which will make it possible to have free access to the interior of the reel at any time necessary.

CLOTH LAYING MACHINE.—M. ISAACS, 15 E. 17th St., New York, N. Y. The invention relates to a machine for piling cloth on the cutting tables in factories preparatory to marking and cutting. Among the principal objects are, to simplify the operation of the machine, to reduce the cost of construction, and to insure accuracy when piling the same on a table.

ATTACHMENT FOR TYPEWRITERS.—F. E. FANGER, Apartado 5138, Mexico, Mex. This invention relates to an attachment for typewriters whereby the user may know at any time and instantly how many lines may still be written on the unused portion of the paper inserted in the machine. The general object is to provide an indicating attachment which may be readily applied to standard typewriter machines in use or embodied in the machine at the factory.

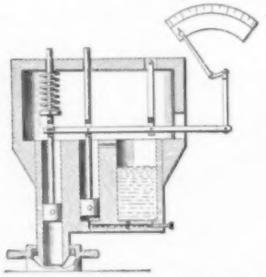
INDICATOR VALVE POST.—R. H. THORNE and F. J. MILLER, Williamsport, Pa. An object of the invention is to provide an indicator valve post wherein one legend bearing plate may be adjusted with respect to the other so that but one valve operating screw of the same pitch need be employed irrespective of the diameter of the valve in any of a number of indicator posts wherein the invention may be embodied.

Musical Devices

PHONOGRAPH ATTACHMENT.—D. MCNEILL, Huntington, W. Va. The particular object of this invention is to suppress as far as possible the undesirable noises due to the mechanical scratching of the stylus upon the record disk or member equivalent thereto by dividing the sound waves into two parallel channels so arranged as to cause the undesirable sounds passing through one channel to interfere with those passing through the other and to neutralize to a considerable extent the acoustical effect of the two groups.

Prime Movers and Their Accessories

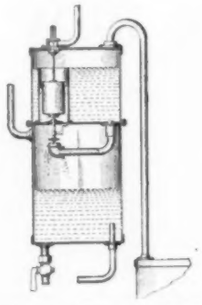
PRESSURE INDICATOR.—M. R. BUCHANAN, Silver City, N. M. This invention has for its object to provide an indicator of the character specified especially adapted for indicating the mean effective pressure in the cylinder


A SECTIONAL VIEW OF THE INDICATOR

of an internal combustion engine and to indicate the load that each cylinder is carrying in multiple cylinder engines to permit the load to be evenly balanced between the cylinders of the engine.

HYDROCARBON BURNER.—K. A. STAHLGREN, 131 Broadway, Newport, R. I. The object of the invention is to provide a hydrocarbon burner arranged to insure a thorough atomizing of the crude oil or other liquid hydrocarbon fuel, and to produce an effective mixing of the air and the atomized fuel to insure complete combustion thereby utilizing the liquid fuel to the fullest advantage. Another object is to insure the formation of a conical-shaped flame.

FUEL SUPPLY SYSTEM.—M. PARNES, 231 2nd Ave., New York, N. Y. This invention relates to fuel systems for internal combustion engines and it pertains more particularly to that type of system in which the operation is carried out by means of a partial vacuum.

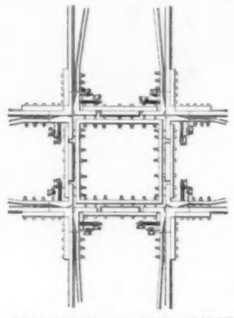

A VIEW WITH THE PARTS IN POSITION WHEN VACUUM IS CUT OFF

It is the prime object of the invention to supply the auxiliary receptacle with fuel from the main receptacle automatically by the creation of a partial vacuum within the auxiliary receptacle.

Railways and Their Accessories

MEANS FOR PREVENTING CLOGGING OF SAND PIPES.—G. H. JOHNSON, address J. L. Taylor, Gulfport, Miss. The invention relates generally to sand pipes of steam as well as street railways, the primary object being the provision of simple inexpensive means to prevent the clogging of sand pipes, particularly at or adjacent to the discharge end of the pipe, where clogging commonly occurs. Another object is to provide an air supply attachment under control of the operator, to direct the sand exactly where it is desired in spite of the influence of the wind or other exterior force.

RAILROAD CROSSING.—J. P. HOUK, New Albany, Miss. This invention has for its object to provide a crossing wherein the shock and jar of the wheels crossing the space between the rails is eliminated, a bridge being


A PLAN VIEW OF THE CROSSING

provided normally spring held in position to support the crossing wheels, but arranged to be moved out of the way of a wheel coming at right angles.

Pertaining to Recreation

TOY BAND WAGON.—C. H. BALKNAP, 323 Washington St., Brooklyn, N. Y. The object of the invention is to provide a toy wherein a combined wagon and music box is provided, arranged to operate independently or simultaneously. Another object is to provide a toy wagon provided with a talking machine and means for connecting the talking machine and wheels of the band wagon with the same driving motor.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject-matter involved, or of the specialized, technical or scientific knowledge required therefor.

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Reducing Trade Routes with Submarine Freighters

(Continued from page 150)

nevertheless be structurally so molded that she could sustain the hydrostatic pressure at a depth of 600 feet. The intention, however, is to restrict diving under working conditions to a maximum depth of not more than 300 feet. According to his calculations, Mr. Lake believes that he can build a ship of his special pattern with less material than the usual surface freighter of equal strength and carrying capacity, and he is convinced that his submarine would be cheaper to operate. Of course, his saving in structural weight is due to his adoption of a circular cross section wherever possible and in limiting to a marked degree the extent and mass of the steel work above water.

With her ballast tanks empty, the ship would have a displacement of about 9,000 tons, and the difference between this and the submerged displacement—4,000 tons—would represent reserve of buoyancy. This could be called into play to enable the boat to rise up through the ice by centering this effort along the rather narrow edges of the craft's "hog back." That is to say, it will be possible to drain the ballast tanks at a depth of 50 feet; and this suddenly applied buoyancy would produce an upward impulse of sufficient moment to lift and to shatter the ice in a direction in which it is least capable of resisting fracture. The upper line of the ridge or deck will be reinforced by a heavy steel rib, and this rib will merge with a very strong conning tower so shaped forward and aft that the ends will, in effect, constitute powerful ploughshares. Therefore, rotten ice or ice several feet thick can be broken and turned aside in a way to clear a channel for the conning tower to forge through. By inclining the bow slightly, with the submarine running at the surface in the awash condition, and then driving ahead, much of the ice encountered during the spring and summer can be smashed and scattered without resorting to total submergence. In this trim, the submergible freighter will remain in contact with the air and be able to use her main propelling plant, be that a steam or a Diesel engine. Mr. Lake is of the opinion that it would probably be unnecessary to submerge entirely except on rare occasions.

The scheme is not to provide short routes only between existing deep-sea ports. The aim is to open up to commerce regions that are now rather inaccessible and yet susceptible of contributing enormously to our stocks of raw materials, etc. For instance, northern Russia and Siberia cover an immense area rich in gold, silver, platinum, iron, coal, timber, and furs; and a portion of this part of the world is capable of yielding yearly many millions of bushels of wheat. There are three great rivers, each a good deal longer than the Mississippi, which drain this area and empty into the Arctic Ocean, where shipping points could be established.

Again, to bring the benefits nearer home, Mr. Lake proposes to use submergible freighters to tap northern Canada so as to provide a ready outlet for the wheat and other commodities of Manitoba and Saskatchewan. He would do this by way of Hudson Bay, which is usually open about six months a year, and thus save more than a thousand miles of the journey which these products have to make in reaching the Great Lakes and thence to the seaboard en route to Liverpool. Conditions in Hudson Bay which would be likely to interfere with or halt transportation in the usual types of steamers would not prevent the effective operating of cargo-carrying submarines. Each ship of the size already mentioned would be able to handle a load of 7,500 tons.

(Continued on page 166)

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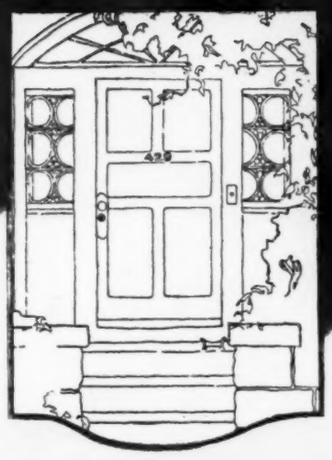

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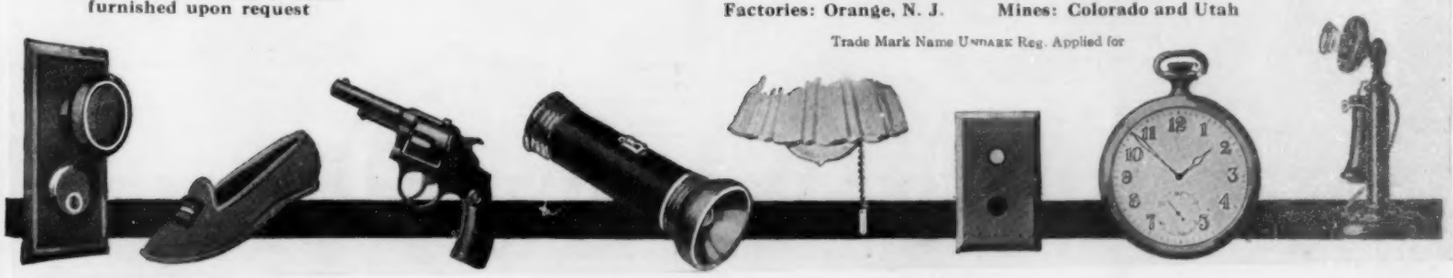

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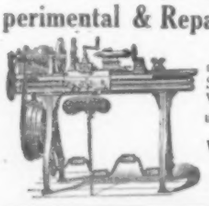

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Reducing Trade Routes with Submarine Freighters

(Continued from page 164)

As Mr. Lake sees it, the under-water ship of trade has claims to consideration even beyond its peculiar fitness to navigate ice-strewn waters. He declares his submersible to be safer to run at all times and that it is practically unsinkable except at the will of those aboard. Despite the fanciful character of the project, it should be borne in mind that Mr. Lake has helped materially toward achievements commonly believed Utopian twenty-five years ago; and it is upon these accomplishments that he now confidently bases his contemplated revolution in deep-sea transportation.

The Aquitania as an Oil Burner

(Continued from page 151)

in each watch, and the loss from this cause amounted to 8,000 horse-power every 4 hours. With oil firing there is a constant flow of oil; a constant furnace temperature; and contraction stresses, due to the inrush of cold air through the open fire doors, are avoided. The steam pressure is constant; the average speed is higher; and the life of the boilers is prolonged.

What Is an Asphalt Road?

(Continued from page 151)

The second course or wearing surface consists of a mixture of hot asphalt, dust, and sand, mixed and rolled in the same way. The sand is finely graded so as to give great strength and stability, while the asphalt binds the whole together closely. The combined thickness of the two courses is usually two and a half or three inches.

Another type of pavement which is more and more widely used both for city streets, boulevards and country roads is the asphaltic concrete or Topeka type. This resembles the sheet asphalt type except that it is generally laid in one course two inches thick, and instead of consisting only of asphalt, dust, and sand, also contains a small proportion of small stone.

The most widely used pavement for country roads is the asphaltic macadam pavement. This is simply a broken stone or macadam road in which the stone is bound together with asphalt. The stone is laid in two courses and the asphalt is poured into it from a machine which distributes it under pressure; the asphalt penetrating the stone and binding it all firmly together. This kind of pavement is often referred to for that reason as a penetration macadam road.

Asphalt is produced from asphaltic petroleum. Petroleums differ very greatly in character according to the field where they are produced. The oils found in the Eastern and Middle Western States are known as paraffine petroleums, while those found in Texas, California, Mexico and South America are known as asphaltic petroleums.

Electrification in Brazil

(Continued from page 153)

is that it gives increased track tonnage capacity by reason of heavier trains, higher speeds and reduction in the number of daily train movements. The other is that the cost of electrification in many cases that have been thoroughly investigated has been found to be considerably less than the cost of corresponding improvements with continued steam-engine operation, and that there is also a return upon the additional capital charge incurred for electrification of from 15 to 20 per cent, resulting from the savings in the operating expense over steam operation.

The eventual electrification plans of the Paulista Railway are for the complete electrification of the line from Jundiahy to Sao Carlos do Pinhal, comprising the greater portion of the main trunk line of the company. This is the second largest railway electrification project in the world, being only surpassed in magnitude by the electrification system on the mountain divisions of the Chicago, Milwaukee & St. Paul Railway in the United States. The St. Paul is electrically operated for a distance of 440 miles. The electrified portion of the road crosses the Rocky Mountains at an elevation of 6,350 feet, the Belt Mountains at an elevation of 5,768 feet and the Bitter Root Mountains at 4,200 feet. The road in these regions presents one of the most difficult problems of transcontinental railroading in the world. Practically all of the important features of that gigantic work will be incorporated in the Paulista electrification.

Seeing in the Dark

(Continued from page 154)

however, the Germans were on the run and trench warfare had practically ceased. The menace of airplane raids, on the other hand, was increasing, and it was decided to develop a similar apparatus for ranging on airplanes. Anti-aircraft guns were rather a joke, insofar as actually hitting anything was concerned. The endeavor was to maintain a heavy barrage and keep the enemy high up so that he could not drop his bombs with accuracy. Sound horns were in use to locate invisible airplanes, and could do so with great accuracy, but unfortunately it took the sound 7 or 8 seconds to get down to the ground from the plane and the shell almost as long to get up there. Usually, by the time the shell arrived at the calculated place the plane was somewhere else. The great advantage of getting the range by heat radiation was that the indication traveled to the ground with the speed of light, almost instantly; in other words, there was no time lag.

Some successful tests were made with model airplanes, and the construction of special thermopiles and a special ranging instrument was at once started. The thermopiles for this work had to cover a much larger field than those for trench use, on account of the great speed of the planes. They were built in a form comparable to the cross hair of an ordinary optical instrument, and are probably the most elaborate thermopiles ever constructed.

This instrument was finished about the time of the armistice, and was tried out in January, 1919, at Langley Field, Virginia. No trouble was experienced in picking up planes a mile away, or in keeping the dark image on the thermopile. By keeping the image constantly on the pile, the speed of the plane could be read directly by the instruments already in use for daylight work. As extended night flying with poor landing fields was extremely dangerous no attempt was made to ascertain the maximum distance at which planes could be picked up. To allow for the low elevation of the plane used in the tests, the motor of a small, low-powered plane was throttled down so that it developed only about 50 hp. It was figured that this small amount of energy would be about equivalent to that coming from one of the large bombing planes at the usual great height. One instrument alone gave only the direction of the plane; two were necessary to give, by triangulation, the height.

The ease with which planes can be detected at night is largely due to this very cold indication of the clear sky. Anything coming in between the sky and the thermopile, either a plane or a cloud, acts as a shutter to cut off the radiation from the surface of the thermopile to outer space, and results in a large warm indication.

The fact that clouds lessened the value of this method of detecting planes at night is not of as much consequence as may appear at first sight. For obvious reasons, raids were very seldom attempted on any but clear nights.

It will be noticed that the original prob-

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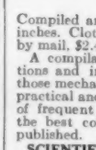

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lem, actual vision at night, had been entirely lost sight of. There was no compensating military advantage to be gained which would have justified the large amount of work entailed in developing such a device. Mere detection in the dark was ample for any military use. As regards the practicability of carrying this work to the point of vision at night, there should be no great difficulty in obtaining a perfect silhouette. It is simply a matter of multiplying the number of units involved. If any commercial use for such a device develops the solution is at hand, but until such a use is suggested it is hardly worth while to undergo the considerable expense of such a development.

Harvesting the Hay the Latest Way

(*Continued from page 157*)

work much better than the smaller outfit, which requires the same supervision on the part of man. An even more efficient rake for use on large areas is the side-delivery rake, for it enables the hay loader to start taking the hay from the windrow as soon as the side-delivery rake has made one double windrow across the field.

On some farms where considerable hay is raised, it is the custom to bunch the hay by hand, but this is an expensive way compared with the method of bunching with a two-horse sulky rake. Such an outfit can bunch 30 or more acres per day, and a boy can do the work as well as a man.

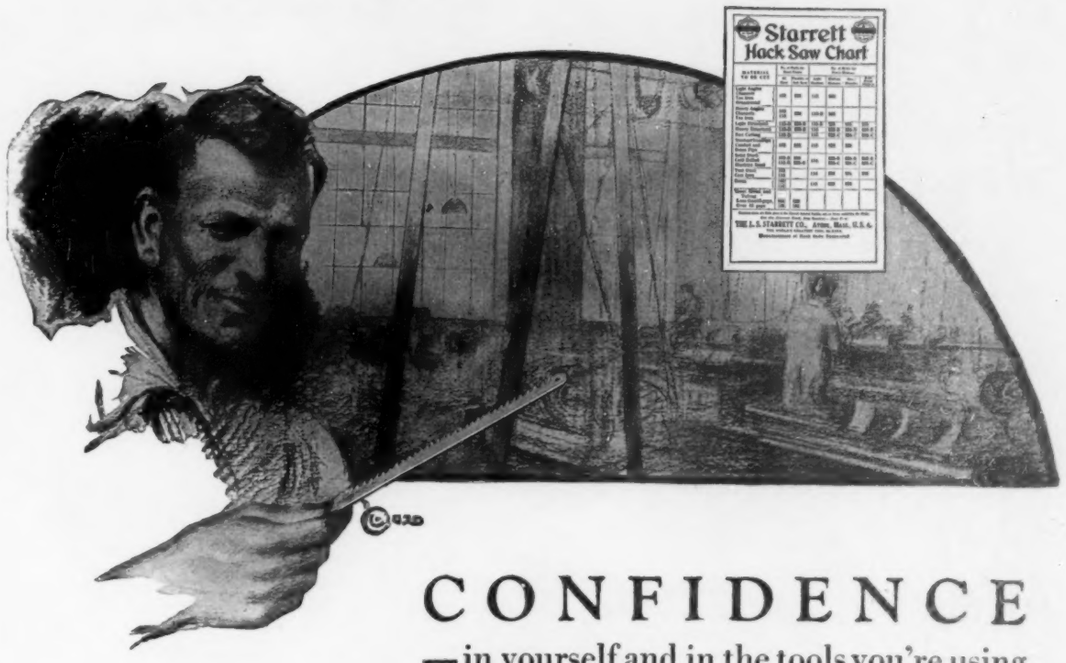
Out in the West, which is a section of "magnificent distances" and everything is done on a big scale, the haymakers have perfected a sweep-rake which reduces by about 50 per cent the labor requirement for harvesting hay, and this method is equally adapted to conditions in the East and South. It is comparatively inexpensive to build and costs little for repairs, and it eliminates a great deal of the irksome hand labor. With the sweep-rake a boy who can drive a team can do the same work as a man.

The sweep-rake consists of several long wooden teeth lying almost flat on the ground, pointed at one end and fastened to a strong framework at the other. The points are sometimes fitted with steel caps over the ends of the teeth and shaped so as to prevent them from running into the ground under ordinary conditions yet so as to slip under the hay, no matter whether lying in piles, windrows or swaths. The teeth usually are about 8 feet long and placed approximately 1 foot apart. The total width of the rake ordinarily is about 12 feet, containing 13 teeth. This gives a surface approximately 8 by 12 feet on which the hay can be loaded and carried.

In operation, the horses or tractor used for supplying power is hitched behind, and the rake is pushed forward gathering up the hay as it goes. The quantity of hay which can be loaded on a sweep depends somewhat on the condition the hay is in, but principally on the skill of the driver and the amount of power available from the horses or tractor. A skilful driver can carry a load of half a ton, and the use of the sweep-rake in large fields will prove very efficient. They are particularly valuable when it is necessary to rake up and stack hay in the field, when a heavy rainstorm threatens.

Another labor-saving device in haymaking that has been perfected in the West is the hay stacker. Where hay is stacked by hand the work is backbreaking and requires strong men, while with the use of the mechanical hay stacker boys can replace men for some of the operations.

Hay stackers are of two general types, according to the way they handle hay. One type has teeth on which it receives hay brought to it by push rakes, and the other handles the hay by means of the harpoon fork, grapple fork, or sling. The first type is represented chiefly by the



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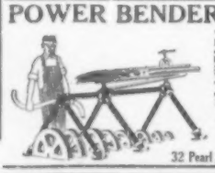

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"overshot" and the "swing-around" stacker. Each of these has long wooden teeth, like those of a push rake. The push rake drops its load of hay directly on these teeth. When the push rake is operated properly, there is no necessity for hand work, except that occasionally it may be necessary to gather up scattered hay with a fork when several push rakes are used. Two horses, or a tractor, are used to elevate the hay to the proper height to be dropped on the stack.

The second type, stackers that do not receive hay directly from push rakes, but handle it by means of horse forks or slings, are usually home-made stacking outfits, and there are a number of these. The cable stacker is one of the simplest and most generally used, and consists of an A-shaped frame higher than the hay stack to be built, to which is fastened a steel cable on which the carrier travels. The materials for such a stacker can be obtained on the farm or from any hardware store. The single-pole or derrick stacker is used to a considerable extent, and it consists of a single pole long enough to make a stack of the desired height, to which is fastened a shorter pole, or boom, at right angles. Three pulleys, about 100 feet of rope, and a horse fork complete the outfit. Where a number of stacks are to be built, it is customary to mount the pole on wheels or on runners, which can be easily moved. The pole is supported by three or four guy ropes or wires.

In what is known as the "Black Belt" in Georgia, Alabama and Mississippi, there has been developed a successful type of truck for curing hay. In this section the principal kinds of hay grown for market are alfalfa, Johnson grass, and alfalfa and Johnson grass mixed. The hay-making season covers a period of several months, and from three to five cuttings are obtained per year. The great drawback in producing hay, however, is the difficulty in curing the hay during unfavorable weather. The hay-curing truck was designed to enable the grower to cure hay during rainy or cloudy spells of weather when all ordinary methods of curing in the field failed.

The curing truck is a device which supports hay during the curing process, protecting it from rain and from moisture in the ground. It requires no more man labor or horse labor for loading, unloading or hauling than do the more familiar methods of curing.

The truck is quite similar to the ordinary hayrake. It is 12 feet long and 7 feet wide and will hold from 1,500 to 2,000 pounds of cured hay, depending on how much the hay is cured when put on the truck. The back is supported by two 16 to 20-inch steel or iron wheels running on an axle placed about 4 feet from the rear end of an A-shaped frame. When a loaded truck is not in motion, as when left in the field for the hay to cure or while it is waiting to be baled, the front end is supported by a 6 by 8-inch wooden block or "trigger" of sufficient length to hold the truck level. This trigger is fastened between the two main frame timbers by a heavy bolt, enough play being left so that it swings easily by its own weight. When the trigger is not in use the free end, pointing to the rear, drags lightly on the ground. The trucks are moved by means of a two-horse team and by reason of their being moved from place to place, the hay can be either left out in the open on bright days or placed under shelter in times of storm. A canvas covering will protect the hay from the top, and the hay being off the ground, will prevent being spoiled by excessive ground moisture.

The Racing Airplane of the Future

(*Continued from page 158*)

will be built also of thin sheet metal, and will be generally elliptical in cross section; two very light trusses, one horizontal, the other vertical, extending from the operator to near the tail. The chords of these trusses will be formed of light T-iron.

To provide for the heavy loads and stresses that are concentrated at the wings and motor, the T-irons of the trusses will be increased in depth and run entirely around the forward end of the body, forming, at their intersection in the nose, a strong construction for carrying the motor. Additional strength will be provided by transverse diaphragms. It is understood, of course, that all of this metal work will be specially rolled in extremely light sections, and that the material will be some alloy, such as vanadium steel, which in experimental specimens, as noted on our editorial page, has shown elastic limits running up to over 200,000 pounds to the square inch. The motor of from 75 to 150 horse-power, according to the size of the airplane, will probably be of the revolving type; the Gnome motor having shown itself to be the ideal airplane drive.

Turning to nature for guidance again, we find that the fast-flying birds fold their legs snugly beneath them when in flight. The racing airplane must do the same. We show a suggested arrangement for a folding chassis, hinged just below the body, and provided with a yoke which leads from the axle up to the crosshead of a piston rod, which, with the guides and cylinder, is carried by the T-iron that forms the bottom member of the vertical truss. The cylinder is provided with a two-way valve and connections by which compressed air can be introduced to the forward or after end of the cylinder. When the chassis is down and in operation, the compressed air acts as a cushion to provide a certain amount of fore and aft movement to the wheels. As soon as the machine rises, a throw of the valve introduces compressed air at the forward end of the cylinder, and the chassis is drawn up snugly against the body. A small tank of compressed air, which supplies the folding mechanism, also supplies a small cylinder of similar construction placed transversely to the car, which operates the movable wing tips. The two-way valve of this cylinder is controlled by a small gyroscope, which may be thrown out of gear when the airman wishes to make a turn, or perform other evolutions.

In answer to the question as to what speed may be expected from a machine of this general design, we think it will be agreed that, in view of its sweetness of form, the complete absence of wires, struts and other energy-consuming surfaces, and the fact that because of the smoothness of the steel surface, skin friction will be reduced to a minimum—it is conservative to expect from such a machine, after it has been developed by experimental work, speeds of from 100 to 125 miles an hour.

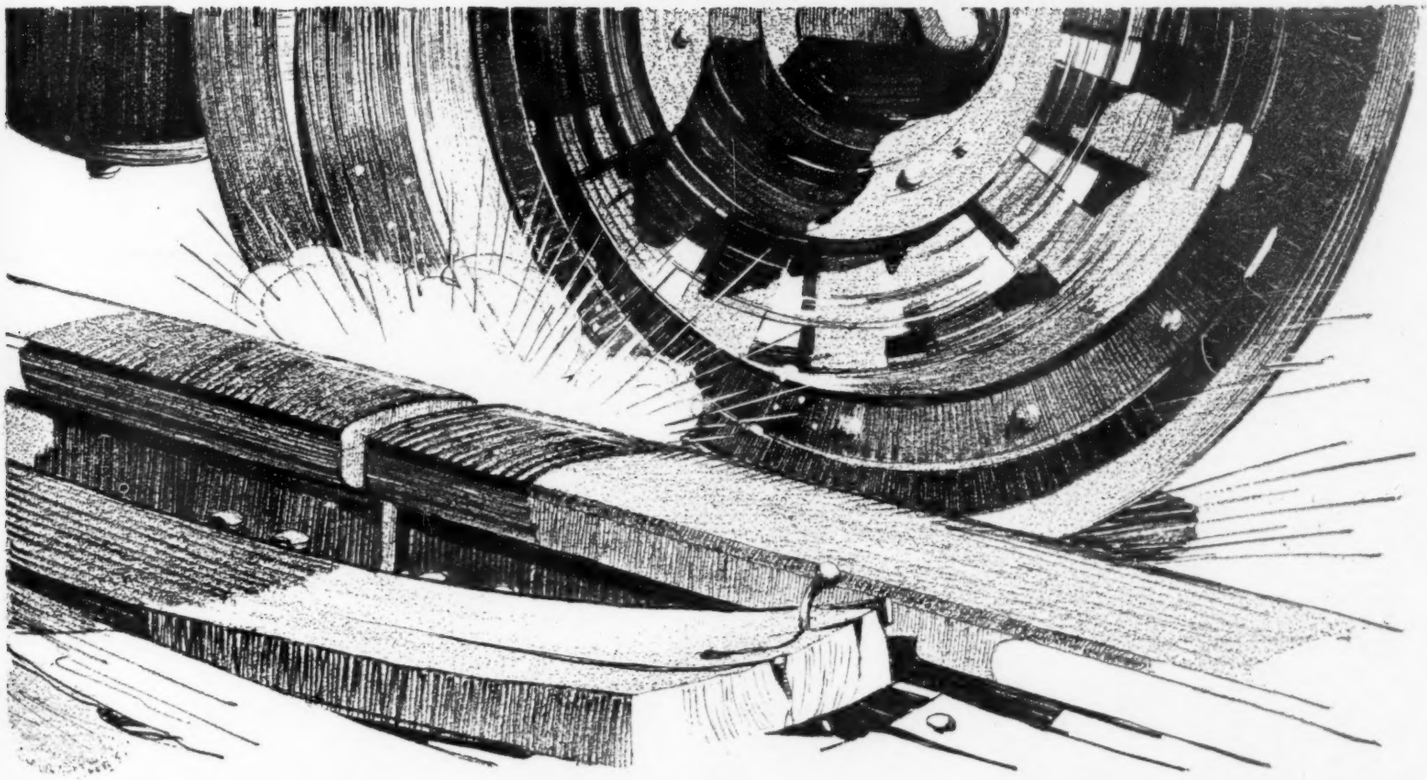
It would be interesting to see what Mr. Herreshoff could accomplish, if he applied to the steel airplane the same constructive genius which enabled him to produce such fine results with steel racing yachts.

Helmets and Body Armor in Modern Warfare

(*Continued from page 159*)

seded the "porridge bowl" English helmet. It was made of manganese steel, and it has the advantage over the old type that it protects the back and sides of the head better than the earlier model.

We show also an American experimental back plate which is laminated. It is made up of a large upper plate, two intermediate pieces, and a lower-most plate, or *garde reins*. These elements are riveted together and are made interflexible by the use of slotted grooves in which the rivets can travel, as in the old-fashioned "alemayne rivets." The back plate is made to suit wearers of many sizes, and it is cushioned with sponge rubber that serves to protect the wearer against injuries from indentation of the metal. It will stop a bullet traveling at 1,000 feet per second.



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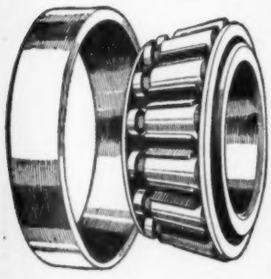

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